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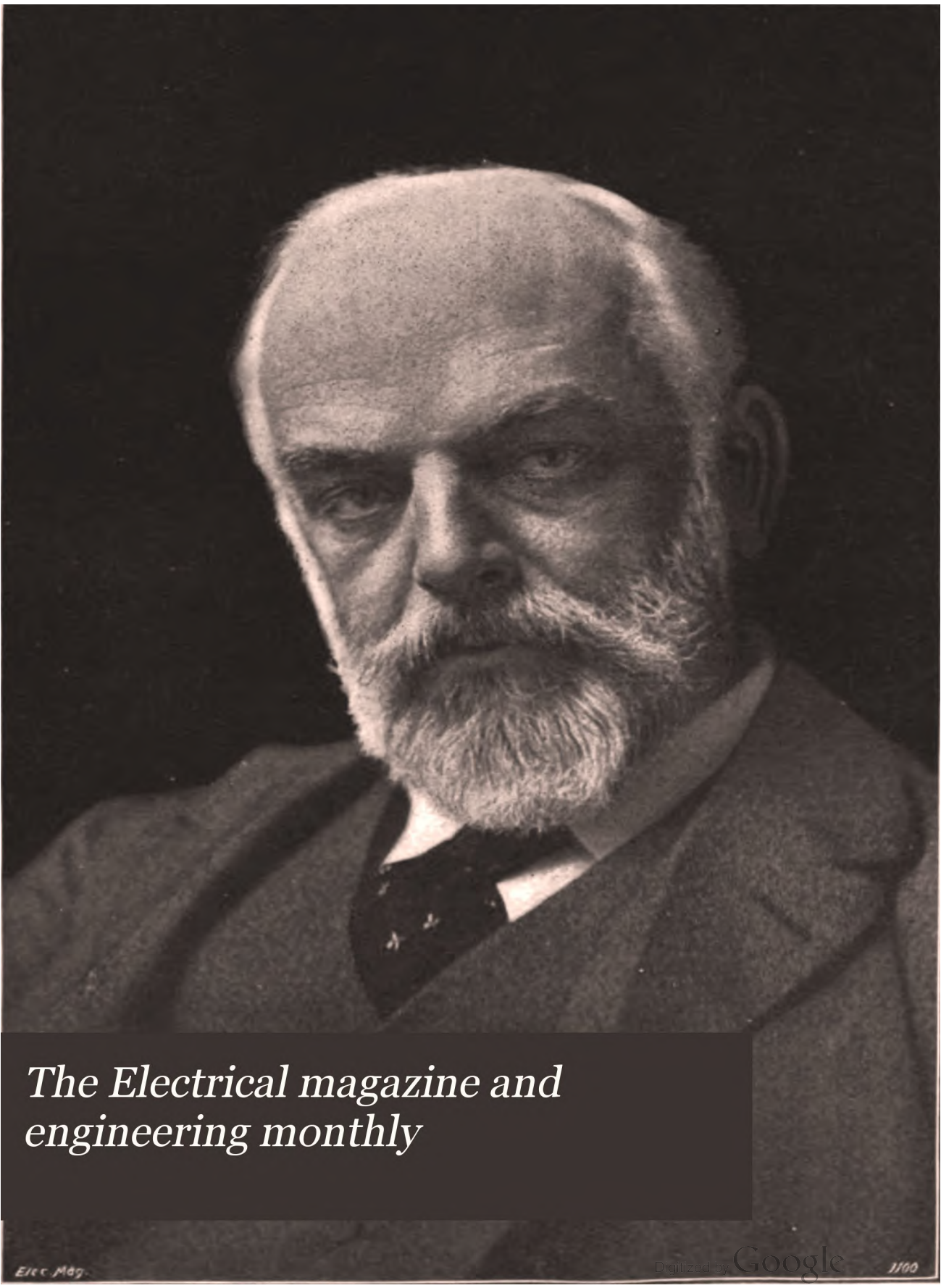
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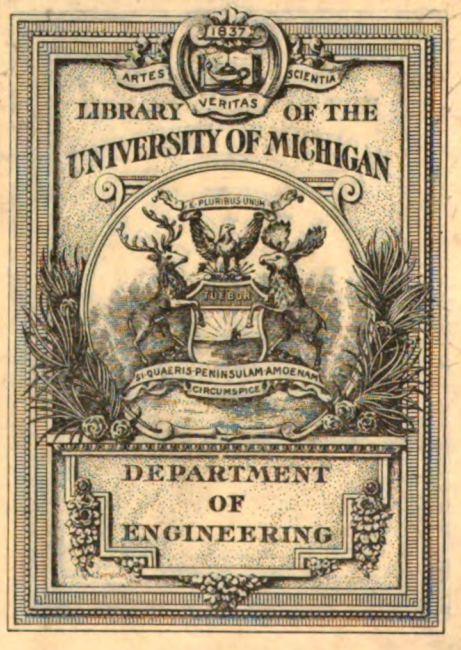
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10/6 GLAD!

"I am afraid I cannot give you in words my opinion of your magazine. Suffice to say, I read it directly I obtain it. I cannot refrain from adding that I am somewhat like the American, who, when asked to express his sympathy for an injured person, said, 'Well, I guess I'm half-a-dollar sorry'; the difference being that I am 10/6 glad, so herewith please find P.O. for 10/6, amount due for annnal subscription to *The Electrical Magazine* for 1905."—G. GOODMAN, Southall, Middlesex.

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The Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. III. NO. 1. (13th Issue.) LONDON. JANUARY 31, 1905

With this Issue

THE ELECTRICAL MAGAZINE celebrates its first birthday. I have supreme satisfaction in recording this fact. To win approval and justify existence is a great thing; to jump, figuratively speaking, from infancy to vigorous manhood in twelve months may be said to be phenomenal, yet this is what THE ELECTRICAL MAGAZINE has done. Its birth in January of last year was heralded with many distinct marks of appreciation, but it has had to outlive strong opposition and to fight unforeseen difficulties. The period just elapsed has been one of great anxiety and very strenuous effort. The net result is that in one year THE ELECTRICAL MAGAZINE has succeeded in securing a premier position among high-class progressive industrial publications. To-day it stands in the front rank of the world's electrical papers, with a circulation and prestige second to none. Its numerous readers and subscribers constitute a record, and can be numbered by thousands extending to the remotest parts of both hemispheres.

I am not satisfied, however. My intention is to make this journal of such increasing value and importance to electrical men that it shall become an institution wherever electrical research or work finds a place. To that end, I have on hand a comprehensive programme for 1905, and no time, pains, nor expense will be spared to consummate it. I need hardly ask for the renewed confidence of those who have supported the Magazine during the first year of its existence—a year of unexampled trade depression, with money abnormally tight—but I wish to point out to both old and new friends that whatever they contribute to the increasing success of this paper will most assuredly advance the interests of the great world-power which it is endeavouring—and I hope with credit—to effectively represent. I appeal as much to manufacturers and consultants as to aspiring students; the latter are to-day the makers of the world's progress to-morrow. To manufacturers THE ELECTRICAL MAGAZINE presents exceptional opportunities for world-wide publicity of their productions. To students I offer special inducements to become subscribers. I cordially invite inquiries and correspondence, and will see to it that this journal disappoints no one. It is here to fulfil a mission, and will fulfil it.

In conclusion, it affords me much pleasure that this Birthday Issue of THE ELECTRICAL MAGAZINE synchronises with a record of the great events which have taken place in the electrical world during 1904. At one and the same time the present issue constitutes the first Anniversary Number and the Souvenir Issue of the American Tour.

Theo. Feilden.

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THE AMERICAN TOUR.

General Impressions and Reflections.

IN view of the special contents of this number, I would like to preface the story which follows with a few general remarks.

It seems almost superfluous to say that I found America a country of gigantic possibilities. Stupendous as are the schemes, electrical and otherwise, which have emanated from the brains of her foremost men, they will undoubtedly be eclipsed and yet eclipsed in the future. Whilst it is true that in most modern progressive countries there is no royal road to success and fortune, it is doubly true of the United States. Every boy that is born is a prospective President of the Great Republic. Every man with energy and brains can attain the highest goal of his ambition. They cultivate original thought and enterprise in the States. They recognise ability and mental capacity at sight, not discarding a man's conceptions and ideas as in the Old Country. Lads with bright and new thoughts are encouraged, artisans and mechanics with novel suggestions are given the full benefit of their thoughtfulness. What does this mean? It means that the nation from the lowest to the highest man in the Union is on the alert, ever assertive, ever alive to possibilities and recognition. No wonder the country is prospering by leaps and bounds, no wonder its trade is expanding yearly beyond anything dreamt of in our philosophy. Their training institutions are alone a revelation! Not that we haven't good ones in Great Britain, but there are not enough of them nor are they on such liberal and thorough lines as many in the States. Our nation should be strongly and aggressively aroused to this fact, the rich men here should give of their best to the present generation and for posterity as they do in the States, the municipalities should be forced to a sense of their responsibilities, and the Government should deal in a far more liberal spirit with national physical research and scientific work. England made her industrial pre-eminence in the years that are gone through the pioneer achievements of her sons, presenting the most conspicuous example of glorious attainment and earning undying fame on the calendar of the world's progress for her investigators and manufacturers. Her great start, however, and the facility with which she secured and retained markets made her business men in a sense lethargic and super-confident, with the result that, though not idle, she has to a large extent rested on her laurels, and relied on prestige. No longer can she afford to maintain this attitude; for now and all time if we are to keep on top we must put forth the most strenuous exertions and remodel our methods, copy if needs be, as America has copied from us,—and improve on the model. It can be done.

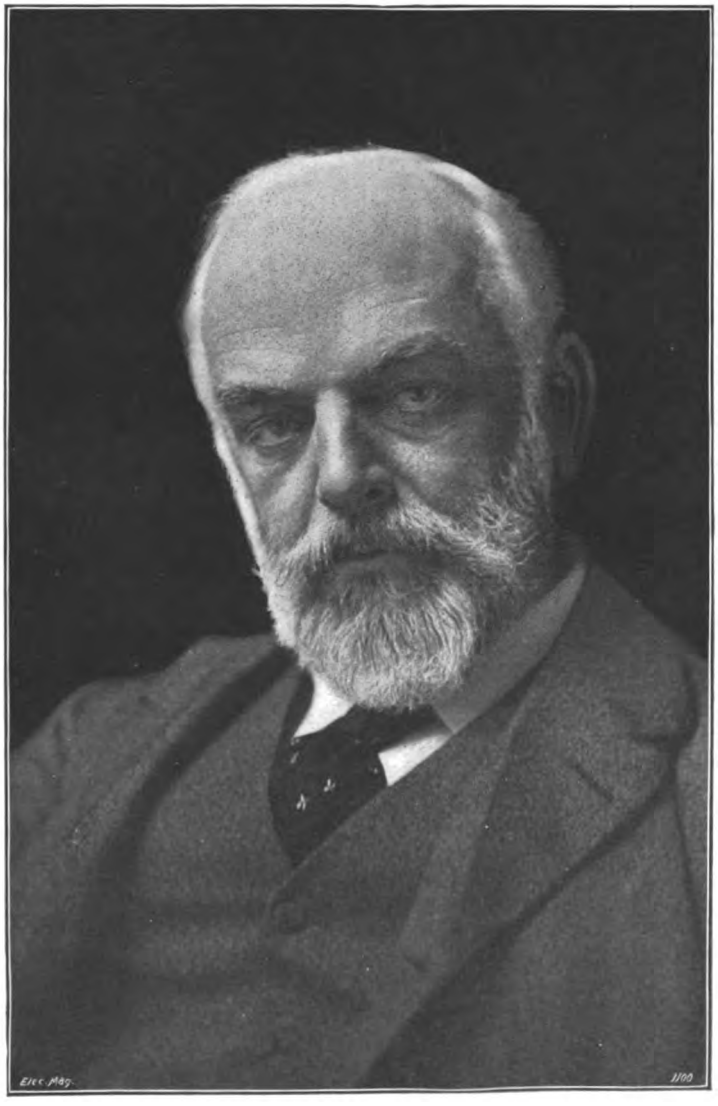
As to our good friends the Americans themselves, judging from those I met, I have nothing but unqualified praise for their courtesy, geniality, generosity, and fair dealing. Perhaps I was fortunate in meeting the high-grade men of the industrial and commercial community, men whose instincts and aspirations keep them in an atmosphere of emulation, men who by virtue of their training and environment possess those attributes which make for progress with ennobling characteristics. Anyhow, I have formed the impression that a good American—and I met many such in the States—is a right decent fellow to know—a gentleman, a scholar, and a man.

As to the benefit to be derived from our visit, I believe it will have far-reaching results. On these international visits, friendships and connections are formed which are not lightly broken. They make for the advancement of industry and the peaceful arts, and for the good of mankind in general. This tour in particular is fraught with great possibilities for the future. The feelings which animated both British and Americans at the respective gatherings were such as to intensify and cement the respect and esteem with which the men of both countries regard each other. Most assuredly the links which bind the great Anglo-Saxon race together have been strengthened by the visit of the British Electrical Engineers to their cousins across the seas.

T. F.

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ROBERT KAYE GRAY

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The Story of The American Tour



By Theo. Feilden.

TEN THOUSAND MILES IN FIVE AND A HALF WEEKS.

A Record Achievement.

I LOOKED forward to my first trip across the Atlantic with an earnestness and pleasure beyond words. Had the occasion been even one of an ordinary pleasure-seeking or business character, one could scarcely take the journey without a sense of excitement and unrest. But this tour was one of no ordinary character. There has probably never been an official visit made to the United States by a body of representative Britishers engaged in scientific and commercial achievements which carried with it greater potentialities and greater interest. Small wonder, therefore, that each and every one of those who had undertaken the tour were eager and anxious to hear the signal which would proclaim that they were really starting on the first stage of this momentous journey. I believe I was the first man (whilst on the Italian trip) to hand in my name to our late lamented Secretary, Mr. McMillan, as a volunteer for the American tour, some seventeen months previously, since which time I had taken the most intense interest in everything that was done in, or which emanated from, the United States. Since a boy I have conjured up thoughts and aspirations of visiting the Great Continent, but when one gets fixed in serious business avocations in the Old Country it is more often than not a very difficult thing to find time and opportunity to cross the Atlantic. That visit, however, once taken by the average Englishman, convinces him that he ought to have been there

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before. It seems a matter of wonderment to our American kinsmen (as exemplified by the utterances of Mr. T. Martin, referred to later) that so comparatively few Britishers cross to the United States in comparison with the number of Americans visiting Great Britain annually. My own feeling is that the great majority of British business men are not quite so favourably placed as their American cousins in regard to long-distance travel. The desire to cross is equally as sincere and apparent with most of us, but somehow or other many men, who have for years made up their minds that the journey is one that should be taken, have not, for apparently good reasons, been able to avail themselves of that desire. There is a strong probability, nay, almost a certainty, that most of those who joined this official trip would never have seen the shores of the United States but for the legitimate excuse which the special occasion warranted. There is hardly a man among the party who has not expressed the intention to go again, and I will predict that a large number of other English business men who were not on this trip will, after perusal of what is set down in this issue of THE ELECTRICAL MAGAZINE, make up their minds that there is something lacking in their modern education unless they avail themselves of the first opportunity that presents itself for a tour through the great States of the Union.

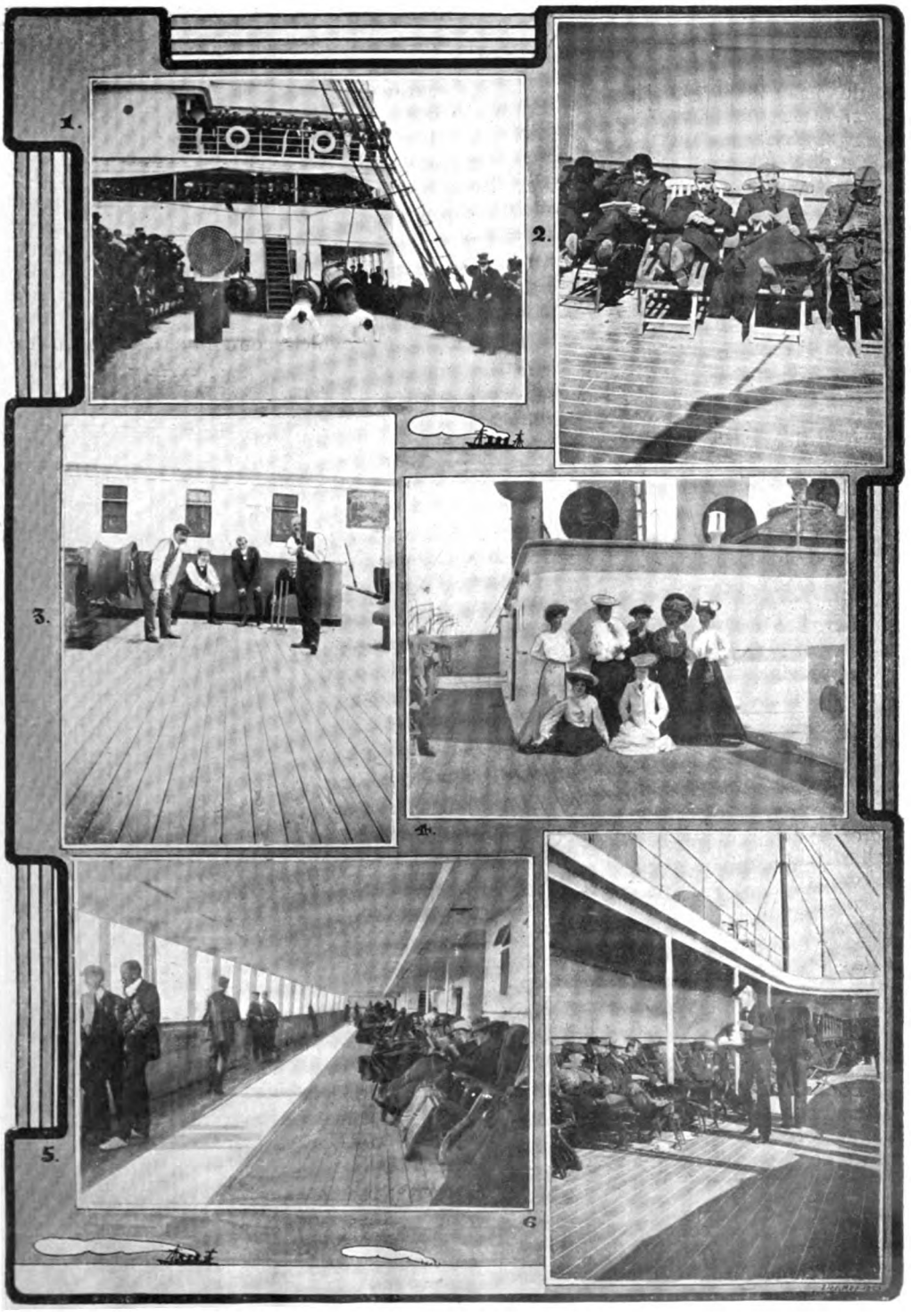
At Euston.

The usual excitement and bustle connected with the departure of the Liverpool "special" was strongly in evidence when I arrived on the platform at Euston half an hour before the scheduled time for starting on the morning of August 25. Of the fifty-one members of our party who were to sail by the ss. *Republic*, only some two dozen entrained at Euston by the special. President Robert K. Gray and our Secretary, Mr. G. C. Lloyd, had proceeded to New York one week in advance of the *Republic*, in order to meet the Reception Committee before the arrival of the main party. Other members had also gone on in advance on their own account to have a preliminary look round, whilst still others, resident in various parts of the United Kingdom, were due to join us on board at Liverpool. Just before the starting of the train, added interest was accorded to the occasion by the appearance of a number of well-known members of the Institution, who had come to the station to see us off and wish us "God-speed" on the journey. Our old friend and fellow traveller, Mr. W. M. Mordey, who rushed up at the last moment, somewhat accentuated the proceedings by suggesting—I believe it was he—that if we survived the "hustle" through the States and the heat of St. Louis, we might possibly succumb to the ices, and the unmarried members of the party to the fair American ladies, but he gave us his blessing and we felt happy. The smart run to Liverpool of three and three-quarter hours, with the pleasant company aboard, seemed to pass in double-quick time, and we had hardly finished chatting over our coffee and cigars when the "special" steamed into the Riverside Station, practically to the minute. Here the smart uniformed officials of the White Star Company were in attendance to collect luggage and despatch it to the steamer. The work of transference was performed in the usual expeditious manner, and shortly after I got aboard I found, thanks to the excellent arrangements which had been made, that my trunks, other than those specially labelled for the baggage room, were safely installed in the state room to be jointly occupied by Mr. F. H. Nalder and myself.

The Start from Liverpool.

What with viewing the animated scene on the landing-stage, the greetings and conversations that passed between ourselves and friends who had come aboard to give us a final send-off, and a cursory glance round the huge vessel, the three-quarters of an hour allowed from the time of embarkation to starting passed quickly enough, and before we realised that the time was so near, the signal sounded for the visitors on board to go ashore. Ten minutes afterwards we were under weigh on the eventful voyage. I had cautiously made inquiries from Mr. Lloyd and elsewhere in regard to the tonnage, comfort, and steadiness of the vessel selected for

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ON BOARD THE "REPUBLIC" (No. 1).

1. Sports: The Obstacle Race. *2. Dr. Glazebrook, Mr. McLeod, Mr. Marr, and Mr. Morse very busy.*
3. A Great Hit! *4. The Ladies of the Party.*
5. On the Promenade Deck. *6. Afternoon Tea.*

Photos by Messrs. Morse, J. Lynn Marr, Barnes, and W. H. Scott.

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our trip across, and was assured that we should have accommodation of a high order. I was not quite prepared, however, for my subsequent experience. The vessel surpassed in every way my most sanguine anticipations. One of the newest of the White Star Line, the *Republic* from first to last is a marvel of ingenuity, skill, enterprise, cleanliness, and comfort. In my opinion she is second to none in the White Star fleet, not even excepting her younger and greater sister, the *Baltic*, on which I returned from the States and of which more anon. It might be interesting here to give one or two brief facts concerning the *Republic*. She registers 15,400 tons; her length is 570 ft.; width, 87 ft. 8 in.

* * * *

One can form no conception of the capacity of these huge liners by mere figures, and their graceful outlines take away all ideas of mere bigness. The graceful proportions everywhere minimise to a great extent the question of size, and one has to get acquainted with the ship, which takes some days, before a true appreciation of her dimensions can be formed. I must confess that what concerned me most was the question of steadiness. I was informed that even if we had a fair sea on it would not be perceptibly felt. There was not the slightest exaggeration in this. When we cast away from the pier I hardly realised that we were moving, and on a sea which would have greatly disturbed the equanimity of the majority of passengers in a good-sized steamer, we were all seated at dinner without any feeling of discomfort. One could almost imagine that we were dining in a luxurious hotel on *terra firma* instead of in the saloon of an Atlantic liner which was going for all she was worth.

The space at my disposal will not permit of any extended account of the voyage to Boston, or a number of interesting details might be given. The main facts are that the trip across was full of incident and enjoyment, and the passage everything that could be desired. We started with a moderate breeze and in fine weather, which strengthened to a fairly strong W. to S.W. wind the next day and moderate sea. On the fourth day out we had a pretty strong W.N.W. wind and a rough swell. This was our worst day, but in view of the magnificent qualities of the vessel there was scarcely anybody on board of our party that felt it. The rest of the voyage was spent in beautiful weather, and we performed the 2,616 miles in 7 days 1 hour and 10 minutes, arriving at Boston a few hours before the scheduled time. I have referred in a previous issue of THE ELECTRICAL MAGAZINE to the entertainments which were held on board and promoted by members of our Institution, and which contributed so much to the enjoyment of the passengers and the material benefit of the Seamen's Benevolent Institutes at Liverpool and Boston. As a matter of record, however, in this issue I should like to state that on August 30 and 31 some excellent athletic sports were organised and carried out, the proceeds being in aid of the American Relief Society, Boston, and Seamen's Orphanage, Liverpool. The chief features were a tug-of-war, England *v.* America, in which the English were victors, and an obstacle race, the winner being Mr. F. O. Mills, he defeating American athletes who competed. A concert was also organised for August 31, and carried through with remarkable success. The programme was conspicuous for its variety, and among the entertainers were the following: Mr. C. C. Hawkins, Mr. W. Geipel, Mr. R. Hammond. In our honour a ball was given the night before we landed, on the promenade deck, for which there was a special electrical display, lights being very delicately and tastefully strung along the rigging, with a background of the national flags of the United States and Great Britain. The chief electrician of the *Republic* is to be specially thanked in this connection for his achievements in the lighting scheme and for the trouble he took in the matter.

Before leaving the *Republic* I feel it my bounden duty to say that the *cuisine* was of the very best order, and the service in every respect excellent. No pains or trouble seemed to be spared by those responsible for the comfort and welfare of the passengers.

Nearing Boston.

As we approached Boston Harbour the question of the Customs arose. It had

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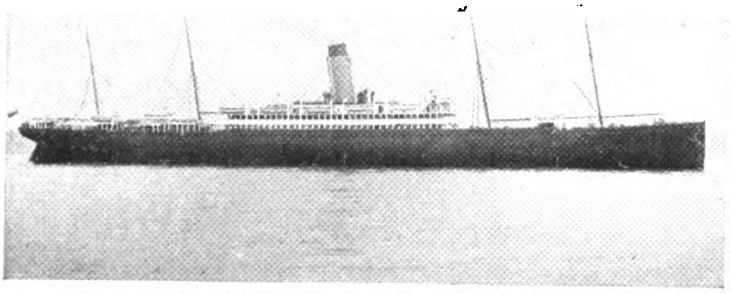
ON THE "REPUBLIC" (No. 2).

1 & 2. Our Party and the Captain (Commander J. McAuley).
3. The Victorious British Tug-of-war Team. ***4. The Comb Band.***
5. Col. Crompton and Mr. Feilden on the Boat Deck. ***6. Prof. Perry, Miss Perry and Mr. Hayashi.***

Photos by Messrs. Pyne, Marshall, Longbottom, Barnes and Morse.

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been intimated to us that, for the convenience of the party, the United States Customs officials would board the steamer shortly before its arrival, in order to pass the baggage and personal effects, thus obviating any delay on landing. The White Star Company had also very kindly agreed to make special provision for facilitating the Customs examination and the immediate transport of the baggage to the Hotel Vendôme in Boston by placing the luggage of the whole party together in the baggage room and not in the hold. Still, many of us had visions of comparatively big fees to pay on such things as English-built cameras, &c., a goodly number of which the party owned. We were agreeably surprised, therefore,



S.S. "Republic."

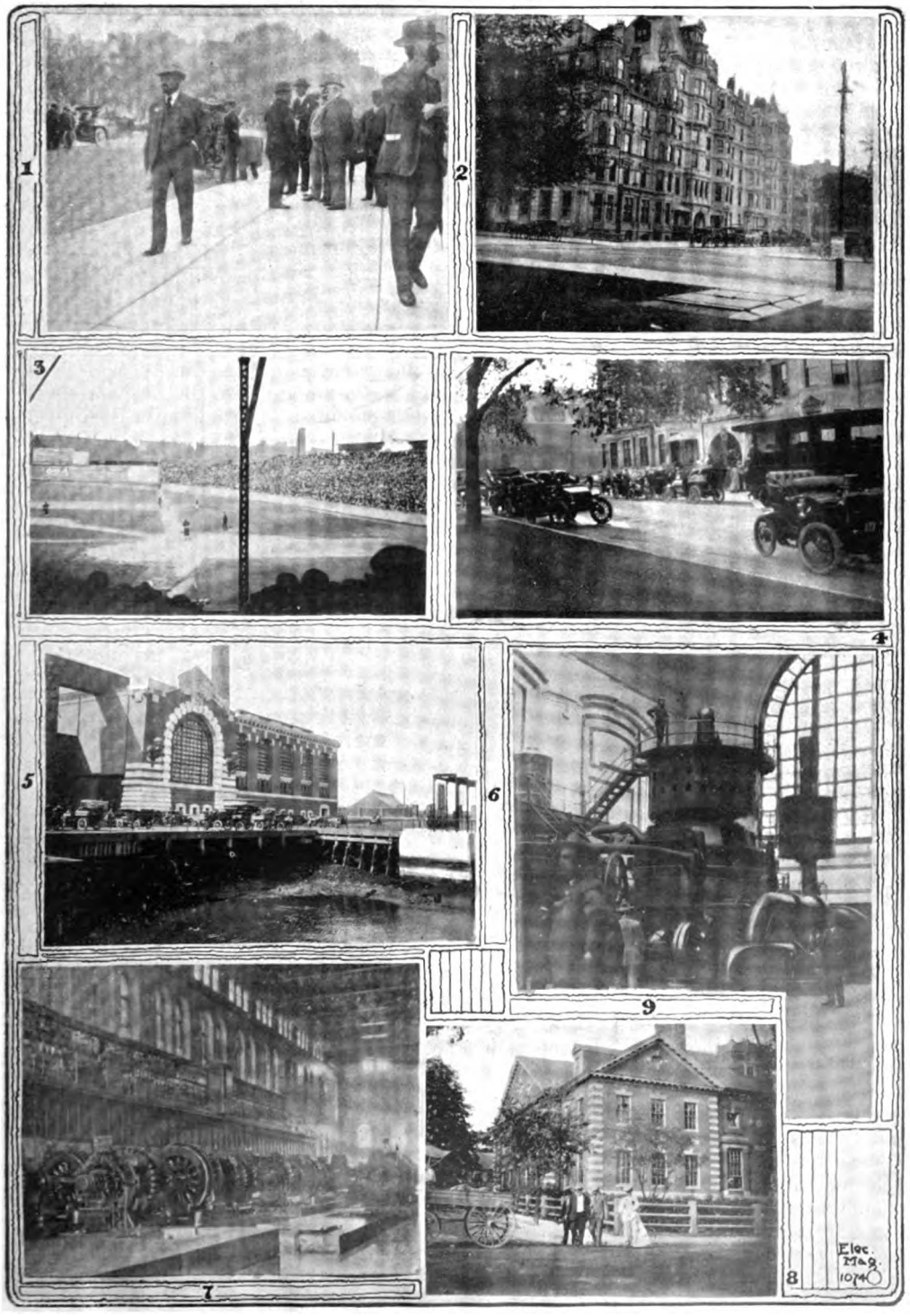
to find that little or no trouble was experienced, and I believe I am right in saying that this was largely due to the indefatigable efforts and courtesy of the Boston Reception Committee, represented by Messrs. Charles H. Hodgskinson and George H. Lyman, who, with our Secretary, Mr. G. C. Lloyd, and President Gray, met us at quarantine. The two latter gentlemen arrived in Boston from New York the night before, and by special permission of the United States Treasury were enabled to come down on the Customs boat on the morning of our landing. Arrangements had been made for a party of eight to meet us in the Lower Harbour, but the steamer entered port so much earlier in the day than she was expected that the others did not arrive at the foot of State Street in time to take the Government steamer.

I was informed that it was due in a measure to the presence of the British electricians on board that the *Republic* made such a fast voyage. Before her departure a cable message was sent to the Liverpool office from Boston asking that, if possible, the *Republic* land our party on the afternoon of September 2 at the latest, and also that the ship's officers show the delegates and other members of the party every possible courtesy and attention. That these requests were more than complied with is shown by the result, and I take this opportunity of publicly endorsing the praise which our members extended to the ship's officers and attendants. In their turn, the officers expressed the conviction that the English electricals were the jolliest set that ever came across the Atlantic, which made it a pleasure, rather than a duty, to serve them.

At Boston.

Within forty-five minutes after landing at the pier the whole of our party, with the question of tariff passed out of mind, were driving through the streets of Boston in special carriages—provided by the contractors, the Raymond and Whitcomb Company—which had been awaiting us, on the road to the Hotel Vendôme, which had been selected as our headquarters during our stay in this city. My first experience of America, on taking my seat by the driver of one of the conveyances, was that of a fire. We had to make a slight detour, as the ruins of a huge building in front of us were still smouldering. The driver confessed to me that that was "only a little flare-up," a mere diversion; what he appreciated, according to his statement, was—in his own words—"a million-dollar fire." Within an hour from the time we landed we were informed that, as we were well ahead of time, Mr. C. L. Edgar, the Chairman of the Local Reception Committee of the American Institute of Electrical Engineers, had thoughtfully arranged a visit to a big baseball match, which was to be played in the afternoon

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BOSTON.

1. A Group of well-known Men.
2. The Vendome Hotel.
3. Base-ball Match.
4. Automobiles for our Party outside the Vendome.
5. Exterior, L Street Station.
6. Curtis Turbo Unit in L Street Station.
7. Arc-lighters in Old Boston Edison Station.
8. At Harvard.

Photos by Messrs. Morse, Hayashi, Cormack, Atchison, and Marshall.

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between the crack teams of Boston and Cleveland. Owing to the striking difference in the temperature of Boston to that which we had experienced but a few hours earlier a number of the party were prostrated and could not be tempted out. I confess to a feeling somewhat resembling suffocation at the time. The air was exceedingly heavy and humid, and the sudden contrast was so great that I thought an iced bath for a few hours would be better than a baseball match. However, after a bath less chilly and of less duration, and a complete change of raiment, I joined the automobile party waiting at the doors of the hotel at three o'clock, and thoroughly enjoyed the very interesting exhibition of skill on the Boston Baseball Ground. Few Englishmen realise what an extraordinary degree of perfection has been attained by the trained men who play in these games. The marvellous precision of the "throw" and the smartness of the men generally could not be equalled in any other game on earth. The many thousands watching this exhibition with breathless interest was a sight to be remembered. Even those spectators who do not understand the game are not always indifferent to its possibilities, as witness the fact that one of our party, who was sitting immediately in front of me, narrowly escaped the full force of one of the balls, which passed with great velocity within an inch or so of his head. This frequently happens, but very few people are hurt, as they are on the look-out. Immediately on the conclusion of the baseball match the rush of the huge crowd was something to witness. A small picture on preceding page will give some idea of the scene.

A Hearty Reception.

On arrival back at the Vendôme we were joined by the Italian party, who had come on from New York by the Fall River boat, accompanied by Mr. John W. Lieb, jnr., and other representative members of the American Institute. One of the first men I met on the steps of the Vendôme on alighting from the automobile, which had been placed at the disposal of myself and two other members of our party, was Professor Moise Ascoli, the genial and respected President of the Associazione Elettrotecnica Italiana, who welcomed me with his customary smile. I and other members of our party who were on the Italian tour in 1903 have not forgotten the courtesy and consideration shown by Professor Ascoli on our visit to his country, and we were all glad to renew our acquaintance. Following refreshments, I, in company with a number of the visitors, was shown about the city, inspecting such buildings as the magnificent Public Library (to see the frescoes in this splendid edifice is alone worth a long journey), the State House, with its gilded dome, the City Hall, &c. A reception and informal supper had been arranged for the evening at the Hotel Vendôme. A large and distinguished gathering attended these functions, as, in addition to the British and Italian parties and our American hosts, there were present delegates from France, Germany, Spain, and other countries, who came over *via* New York. At the supper a special guest was his Excellency Governor John L. Bates, of Massachusetts State. Also present were Messrs. William Jackson, City Engineer; Henry L. Higginson; Howard A. Carson, Chief Engineer of the Transit Commission; Frederick Brooks, President of the Boston Society of Civil Engineers; H. E. Reynolds, Purchasing Agent of the Massachusetts Electrical Company; George A. Kimball, Chief Engineer of the Elevated Railway Company; F. O. Houghton, Passenger Agent of the Boston Office of the White Star Line; J. V. Boyd, and others. Mr. Charles L. Edgar, Chairman of the Local Reception Committee, presided at the reception, and after a neat little speech, in which he welcomed the visitors on behalf of the Institute, he introduced Governor Bates, who extended to us the freedom of Massachusetts and a hearty welcome to New England. In the course of his interesting and eloquent address, the Governor said that Massachusetts, as the birthplace of Benjamin Franklin and Morse and the home of Bell, was particularly fortunate in being the first to welcome in its leading city the scientists and electricians from Great Britain and Italy and the delegates from other countries. He heartily wished one and all a most enjoyable and entertaining journey, and intimated that he would be glad again to see those who survived

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BENJAMIN FRANKLIN. STATUE IN ELECTRICITY BUILDING, ST. LOUIS.
(Boston was the scene of Franklin's historic experiments.)

the rigours of the tour. This was comforting for our first evening, but we braced ourselves for the fight. President Gray, on behalf of the British Institution of Electrical Engineers, and Professor Ascoli, on behalf of the Italian Association of Electrical Engineers, expressed their warm thanks for the cordial reception extended to them in Boston, and Mr. John W. Lieb, jnr., Chairman of the American Reception Committee of the International Congress, who was also introduced to the gathering, likewise made some appropriate remarks. President Gray, in the course of his neat and appreciative little speech, enthusiastically praised the Boston parks, the equal of which he stated could not be found in England. Towards the close of a most enjoyable evening the temperature altered, a cool and delightful breeze blowing.

"Doing" Boston by Automobile.

Saturday morning broke fine and equally cool, and after an early breakfast a large number of automobiles assembled at 8.30 outside the hotel to convey the visitors to various points of interest in the city. The first visit made was to South Boston, to the new turbine power-station of the Edison Illuminating Company. At this place about a score of gentlemen, who acted as guides under the able direction of Mr. Sidney Hosmer, Constructional Engineer of the company, conducted the party round. A little over an hour was given for the inspection of this up-to-date and very interesting station. I make no attempt here to give any description of the magnificent installation at this place, in view of the fact that it is described in another portion of this issue. Incidentally, I might also remark here that I shall deal generally in this, the first section of the Tour Story, with particulars of the visits made and incidents which occurred throughout the journey, reserving more particular details of plant, &c., to be treated upon elsewhere in the Magazine.

Leaving the turbine power-station, the party was conveyed by motor-cars to the headquarters of the American Telephone and Telegraph Company, in Milk Street. The visitors were here received by a committee composed of President F. P. Fish, Vice-President Sherwin, and Messrs. Houston (General Manager), Wright (Superintendent), and Wales (Chief Engineer). A stop of half an hour was made at this place—hardly enough time to thoroughly inspect the plant, but sufficient to give one a good idea of the extent and perfect nature of the undertaking. At 11.30 the motor-cars started with their loads of enthusiastic occupants for a drive over Beacon Hill, through the celebrated park system of Boston. What a drive that was! One that will surely live in the memory for all time of those who had the good fortune to undertake it. President Gray was right when he said that England possessed no parks equal to those of Boston. I doubt whether there is anything of a similar character in the United States. When one passes the gorgeous Venetian palace of Mrs.

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Gardner and gets fairly into the main road which runs through and around the park, grand, beautiful, and enthralling views meet the eye at every turn. The roadways are flanked on either side by huge rocks and magnificent foliage. There are runs for a motor-car here which many men in England would envy. The lovely piece of water called Jamaica Pond—a veritable fairy lake as it appeared to me in the glorious sun—with its little army of swans floating on the surface, and the dreams of beauty which greet the vision at every point, sheltered glades, lovely nooks, and ideal scenery, made it hard to realise that the throbbing machine in which we were travelling had left the busy "hub"



THE ONLY BREAKDOWN ON THE TOUR.

but scarcely half an hour. We seemed transported to another country. I have no words sufficient to praise the way in which this beautiful extent of country, modestly called a park, has been matured and fashioned as a resort of pleasure and recreation for the inhabitants of Boston, whilst being still allowed to retain all the elements of its natural and rugged beauty. The car that I was travelling in was owned by a gentleman whose name I have unfortunately forgotten. He imparted to me much interesting information concerning Boston and its inhabitants, and I am greatly indebted to him for the courtesy he extended and the trouble he took to give me and the other occupants of the car, Mr. Ralph W. Pope, Secretary of the American Institute of Electrical Engineers, and Mr. W. A. Barnes, of our party, a most enjoyable trip. At his invitation, we called at the elegant Country Club in the park for a short inspection, and then turned to make for Pierce Hall, where we were due to meet the entire party at 12.30. As far as we were concerned, however, the return journey was a little unfortunate, as in going down the hill by Soldiers Field on the way to the Stadium—not above the regulation speed, mark you—a slight accident happened to the automobile, and we lost a good half-hour in patching up the defect. We were sorry for the motor-car, which was a splendid little machine in every respect, and equally sorry for our good friend the owner, who was most solicitous that we should not miss one of the most interesting visits arranged for us on the tour, or the excellent luncheon which would be shortly awaiting us.

At Harvard.

We eventually arrived, however, after a short inspection of the Stadium (which reminded me forcibly of the Coliseum at Rome), without further mishap at Harvard University, too late, however, to be formally welcomed by Dr. Kennelly, who had already shown the party through the Museum, Pierce Hall, Jefferson Physical Laboratory, Memorial Hall, and Germanic Museum. We were courteously accorded, however, a rapid glance round the splendid buildings, just in time for the 1.30 luncheon. Preceding the repast, an informal reception was accorded by Dr. Henry P. Wolacott, representing the Corporation of Harvard College. A very excellent luncheon was served, to the greatly appreciated accompaniment of music by members of the Boston Symphony Orchestra. Dr. Wolacott gave us an address of welcome, to which appropriate replies were made by Presidents Gray and Ascoli. Not one of our party will readily forget the beautiful and historic hall in which the luncheon was spread. Its stately walls were adorned with trophies of the chase and the flags of both nations gracefully and artistically entwined. From the handsome ceiling elegant pendants were suspended, and the tables were decorated with floral emblems and many-tinted leaves, which gave an added charm to the scene. Altogether it was a memorable gathering in a memorable place.

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Leaving Cambridge at 3 o'clock, special cars were taken for the return trip over Harvard Bridge to Copley Square, and we were then received at Rogers Buildings by Professor H. E. Clifford and others, representing the Massachusetts Institute of Technology. We were thereafter shown through the various buildings of that institution.

At 5.45 P.M. the entire party assembled in the hall of the Hotel Vendôme and were conveyed in carriages to the Back Bay Station of the New York, New Haven, and Hartford Railroad Company, where train was taken to Fall River. Here we connected with the Fall River night boat, bound for New York.

NEW YORK.

WE landed in New York very early on Sunday morning—I think it was somewhere about seven o'clock. We were within half a mile or so of the landing stage about five, but found ourselves in a very dense river fog with syrens sounding all round us, to the accompaniment of bells clanging and other tuneful and comfortable messages. I think there was a slight feeling of nervousness among those of our party who had installed themselves on the upper deck to try and find out what was going on, as one or two cross-river boats passed dangerously near our bows. I confess that I was glad when we landed. I have no hesitation in saying that I did not appreciate the journey from Boston to New York. The train to Fall River was unusually crowded; and what with getting one's toes trodden on, being jostled and importuned by numerous vendors of sight-seeing pamphlets, together with a few more discomforts, I looked forward to a quiet and invigorating sleep on the boat. I found, however, that I had been accorded a berth which had no window and apparently no ventilation, in the centre of the vessel. We are not all born to comfort, well for us, I think, or we should not enjoy the good things of life when we do fall on them. I like my night's rest, however, as otherwise I'm unfitted for the next day's work. On this occasion I never slept a wink, and was glad to get up about four o'clock in the morning for some fresh air. These Fall River boats are often fearfully crowded, particularly on Saturday nights. On this occasion I should think a hundred or two passengers were sleeping on mattresses—covered with blankets—which were hauled out by the coloured men about 11 P.M. and placed side by side in the brilliantly lighted saloon and along the passages. It seems an institution, and nobody appears to mind.

New York Receives Us.

On emerging from the depot, we were met by the New York Local Reception Committee, headed by the chairman, the ubiquitous and indefatigable Mr. T. Commerford Martin, who, as is well known, is likewise editor of our esteemed contemporary, *The Electrical World and Engineer*, of New York. The committee had automobiles waiting for us, furnished by the New York Transportation Co., accompanied by three 5-ton large electric trucks loaned by the New York Edison Co. Great expedition was shown in getting the baggage and party aboard the motor cars; and the entire company, with its belongings, departed from the wharf by 7.30. The visitors had spread themselves over three hotels, the Waldorf-Astoria, the Fifth Avenue, and Park Avenue. The first named, in which I had booked a room, was the head-quarters of the British delegation, and the last named was selected as the head-quarters of the Italian. Sunday morning was devoted by most of the party to rest, letter-writing, or church attendance. A suite of rooms had been engaged by the American Institute on the first floor of the Waldorf, adjoining the state apartments. These rooms were found very convenient to our party, whose mail, whilst in New York, was expeditiously transferred from the Institute offices in Liberty Street, so that no trouble or inconvenience arose. At the Waldorf head-quarters also the necessary tickets and badges were distributed, and all necessary information accorded our members by the secretaries and committee in charge.

Hudson River and Coney Island Trip.

In the afternoon, by the generous invitation of Mr. J. G. White (of the well-known firm of J. G. White and Co.),

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a member of the committee, a special trip was given by the steamer *Richmond*, of the Starin Transportation Line, to view the scenery of the Hudson River, then—as the official guide truly described it—at its best in the beauty of the early Fall. The steamer started from the foot of West 35th Street, Hudson River, easily reached by all the elevated and street car routes. The start was promptly made at 2 P.M. Soon after the boat started, the party regaled themselves upon ice creams, lobster mayonnaise and various other delicacies, to the accompaniment of a band, one or two of the members of which were, judging from their very comfortable appearance, not averse to the good things of this world in the way of food and drinkables, and small blame to them. It was grateful and comforting to see the way in which they enjoyed their repast after the labours of trombone blowing and other musical evolutions. The delightful hospitality accorded by Mr. White was taken advantage of by over 600 persons, forming the British, American, and foreign party. The day was absolutely ideal, and a large number of pictures were secured by the camera brigade. The trip up the Hudson, past Columbia University, Grant's tomb, and other notable sights, was extended as far as the tide permitted. The return journey included the famous Lower Bay of New York and part of the course of the international yacht races. Mr. White, with a thoughtfulness that was greatly appreciated, had arranged to take the boat to Coney Island, and to arrive off "Dreamland" at the moment when darkness was setting in, in order that the visitors might be permitted to witness the brilliant outburst of electrical illuminations which is such a feature of this resort. The *Richmond* was docked at 7 P.M., with an intimation that the members should be ready for embarkation at ten, or they could return by way of electric car back over Brooklyn Bridge to New York City. For the uninitiated, I might mention that "Dreamland" is the latest spectacular resort at Coney Island, and vies with the original conception at this popular seaside place



OUR MUSICIANS "BETWEEN THE ACTS."
[*Photo by E. Kilburn Scott.*



MR. HAYASHI ON BOARD THE S.S. "RICHMOND."
[*Photo by E. Kilburn Scott.*

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for scenic effect. One can get absolutely satiated with excitement, amusement and entertainment at this extraordinary spot. A visit to the huge ball-room is a sight worth witnessing. The party was furnished with tickets of admission for three of the most attractive features of the entertainment, including the sensational "Fighting the Flames," illustrative of the actual performance of a typical American Fire Brigade. As I usually like to try most things, I did the round of the place as far as I was able, and felt at 10 P.M. that a little rest and quiet would be a good thing. It was somewhere about midnight when our hotels were reached, and bed was a blessing. A very enjoyable day, however, had been spent, probably one of the most pleasant on the tour, and the thanks of our party are due not only to Mr. White, but to the special committee who handled the excursion on his behalf, of which Mr. P. G. Gossler was chairman, assisted by Mr. J. M. Wakeman, and the following members: Messrs. Collette, Reed, Young, Lardner, and other officials of the J. G. White Co.

Labour Day.

On Monday, September 5 (Labour Day), it had been arranged that the party should meet on the steps of the City Hall at 8.15 A.M., and motor cars were in attendance at the various hotels to convey us to the appointed *rendezvous*, where we were received, on behalf of the Interborough Rapid Transit Co., by Mr. L. B. Stillwell, Mr. H. G. Stott, and a number of other gentlemen. Within a very short time after our assembly, a pioneer train, which had been courteously provided by the Interborough Rapid Transit Co., started from the City Hall Station, conveying nearly 700 guests, in order to inspect the system. The special train consisted of eight cars, each carrying about eighty passengers. A number of these cars were of all-metal construction, and were the subject of considerable attention. The train ran at varying speeds, and every opportunity was afforded of observing the construction of the tunnels, track, stations, and general equipment. The platforms of the stations are spacious and light, whilst the walls of the stations themselves are highly decorative, glazed stone of varying tints being largely utilised. I was particularly struck with the comparative purity of the air under ground, and the journey to my mind contrasted very favourably with a trip on the "Tuppenny Tube" in London, the oppressive feeling being entirely absent. There is illumination enough in the tunnels to read by, apart from the lighting of the carriages, which is in every way satisfactory, not to say brilliant. The train ran practically noiselessly to the 59th Street and Columbus Circle Station, where the trip ended.

The motive power used in propelling the pioneer train through the third rail equalled about 2,000 h.p. The journey was most interesting, and I was favourably impressed with the whole undertaking. Leaving the subway at 59th Street, we walked to the Subway Power House, a short distance ahead. This station is the latest addition to the current-generating services of Manhattan Island. I am bound to say that we took an even greater interest in the plant there, which was then near completion and partly in operation, than in the railway we had just left. We were able to inspect the eight enormous dynamos of 6,600 h.p. that were already installed out of the whole battery of twelve. At the time of our visit a large new addition to the power house was being built, and we here had a very good opportunity of noting the method of steel constructional erecting adopted in the United States.

On the Harlem.

After leaving the power house a short walk took us to the New York Central Pier, where we boarded the steamboat *Nassau* of the Long Island Railway Co., accompanied by the cable boat of the Western Union Co. Proceeding up the North River an exhibition was witnessed of fire fighting by one of the largest fire boats of the New York City Fire Department. All manner of evolutions were gone through, the fire boat showing us what it could do with single, triple, and ultimately eleven streams playing simultaneously. Our party indicated their appreciation by their loud applause and cheers. The trip was then resumed, the boats passing into the Ship Canal at Spuyten Duyvil, thus reaching the

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Harlem River, and on to the Kingsbridge power house of the New York City Railway. Here we were received by the chief engineer of the Company, Mr. M. G. Starrett. During this part of the journey a very acceptable light collation was served. At two in the afternoon we left 96th Street for the Manhattan elevated plant of the Interborough Co. at 74th Street on the East River, and, after a comparatively brief inspection, we were taken on to the Water Side Station at East 38th Street of the New York Edison Co., where we were met by Mr. J. W. Lieb, jnr., who, with his assistants, conducted us through this extremely interesting power house. Here we had exhibited to us in operation one of the large new Curtis steam turbine units. After leaving this centre of generation and distribution of current for lighting and power all over Manhattan Island, the party disbanded somewhere about 4 P.M.

A number of ladies accompanied our party, but those who did not care to undertake the power house trip were conveyed in automobiles to Claremont, Grant's Tomb, and other places, under the guidance of the Ladies' Committee.

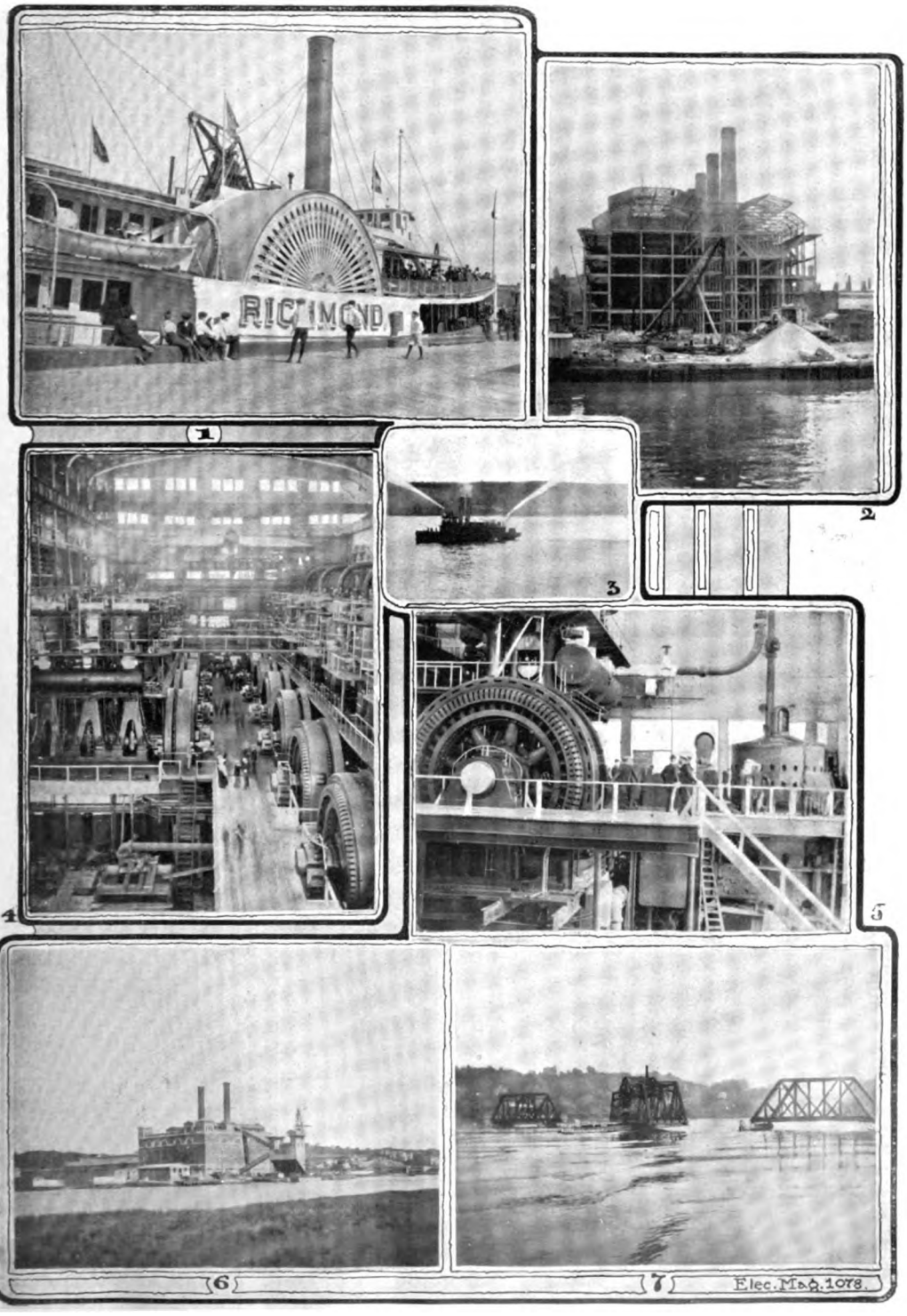
The A.I.E.E. Banquet.

In the evening the American Institute of Electrical Engineers came very conspicuously to the front, and with the co-operation of the New York Local Reception Committee gave a reception and magnificent banquet to the visiting engineers and their friends at the Waldorf Astoria. The reception was held in the Astor Gallery, and was attended by something like three hundred guests, including a considerable number of ladies. The banquet was held in the Grand-Ballroom, which was tastefully draped with the American, English, Italian and other national colours, festoons running round the entire room, with clusters of incandescent lights appropriately introduced. There was a lavish display of flags and flowers, and as dinner was served the hall presented a most brilliant appearance and excited considerable comment and admiration. The seating arrangements provided for the accommodation of six to eight persons at each table. The chief guests were seated at a raised table across the end of the large room. The President of the American Institute, Mr. Bion J. Arnold, presided, with our President, Mr. Gray, on his right and the President of the Associazione Elettrotecnica Italiano on his left. The respective Presidents were supported on either side by many representative gentlemen.

The menu which was provided was a veritable work of art, distinctly striking and original, and worthy of American conception. It measured 17 ins. by 17, and portrayed an old Red Indian chief seated upon a ledge of rock overlooking Niagara Falls. He was gazing with a set look into the misty space, from out of which loomed phantom forms, indicating modern electrical achievements. Over his head a small panel was inserted depicting the Festival Hall at the St. Louis Exposition. This beautiful piece of work was printed presumably in collotype upon a rough deckle edge paper, and the menu itself was in the left margin, which was fastened on to an electric mottled blue cover, across which from left to right ran a flash of lightning. On the right Franklin's kite was depicted, on which was stamped the badge of the American Institute of Electrical Engineers in dark blue and gold. The tail of the kite represented in colours the flags of the nationalities present at the dinner. I noticed that the Union Jack started the flags, and, with that thoughtfulness which is so characteristic of the Americans, they placed the Stars and Stripes at the end, giving the posts of honour to their guests. One of the happiest little things in connection with the menu was the actual old-fashioned key which was suspended by a silken cord from the centre of the kite. These keys were taken off and carefully preserved by the guests. I have described this menu at length because I think it was about one of the most unique things that has ever been done in this connection, and with the feeling that it would be a compliment to our good friends across the water to adapt the design to the cover of the present issue of THE ELECTRICAL MAGAZINE, I present its essential features outside this souvenir issue.

The speeches at the banquet were of a brief character, in view of the fact that our party had to be up pretty early the next morning. President Arnold formally

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NEW YORK.

1. Embarking for the "White" Excursion. 2. Extension to Subway Power House.
3. Fire Boat Display. 4. Interior of Waterside Station. 5. "Dignity and Impudence."
6. Kingsbridge Power House. 7. Spuyten Duyvil Bridge.

Photos by Messrs. Cormack, Morse, Atchison and Feilden.

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and gracefully gave an address of welcome on behalf of the American Institute; and Mr. Fornes, President of the Board of Aldermen of New York, extended a cordial greeting on behalf of the city. Responses were made by Presidents Gray and Ascoli, on behalf of the British Institution and the Italian Association respectively. Mr. William Von Siemens also delivered a few remarks on behalf of electrical engineering in Europe. Following this, Prof. Elihu Thomson gave us an eloquent little speech, welcoming us in the name of the Congress, to which Prof. Perry made a humorous reply, which created considerable diversion. Mr. C. A. Coffin, chief of the General Electric Company, extended a welcome in a short but eloquent address on behalf of the electrical industries of America. The final speech, by Mr. John W. Lieb, Jr., was characterised by a warmth and sincerity which was unmistakable. He spoke on behalf of the general and local reception committees, and the members of our party felt after he sat down that we were indeed among friends. Throughout the proceedings an excellent band played a variety of national airs, which were greeted in turn with considerable applause. Before leaving the banqueting room, a very pretty souvenir was sent round to each guest in the shape of a little plaster cast of the bust of Benjamin Franklin, copper coated, mounted on a cylindrical pedestal box containing sweets. The ices which accompanied were eloquent in the beauty and originality of their designs and size.



CALVIN W. RICE.

On the breaking up of this representative gathering one and all were unanimous in their praise of the way in which the arrangements had been carried out, which reflected the highest credit upon the chairman of the dinner committee, Mr. Calvin W. Rice, and his co-workers, Messrs. C. A. Terry, G. F. Sever, L. J. Magee, C. Townley and T. C. Martin.

THE START OF THE CIRCULAR TOUR.

THE next morning, Tuesday, September 6, we were taken in automobiles from our respective hotels to the Grand Central Station of the New York Central and Hudson River Railroad, and boarded the special tour train, which was composed of Pulman, drawing-room and sleeping cars, one or two of the carriages being of the boudoir type, ensuring complete comfort and privacy. It was a veritable train *de luxe*, and, I am informed, one of the best, if not the best, that has ever left New York. The accommodation was admirable in every respect, and I am afraid to draw comparisons with good-class English long-distance trains. The morning was beautifully fine and fresh, and the sun shone brilliantly. Punctually at nine we started. This was really the commencement of the Special Tour organised by the American Institute, with the assistance of the American travel agents, Messrs. Raymond and Whitcomb, under the guidance of Mr. Hutchins. Special arrangements had been made for refreshments, attention to baggage, and all that might be required. Everything seemed to have been thoughtfully provided to ensure the greatest possible degree of comfort and enjoyment; and I for one can testify to the pleasure it gave me to travel on this luxurious and beautifully appointed train. We had about one hundred passengers on board—quite a little town—but there was no confusion, and everything went apparently

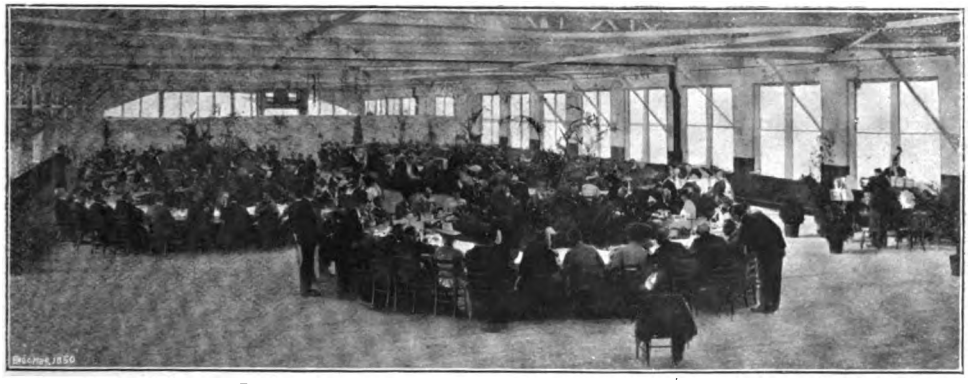


E. W. RICE, Jr.
Chairman of Schenectady Local Reception Committee.

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as easily as a well-fitting glove. Mr. Mullin, as chairman of the Transportation committee, has had his work in connection therewith so much appreciated by our party that he needs no further congratulation from me. A section of the New York Reception Committee, including Messrs. Martin, Wheeler, Crocker, Muralt, Curtis, C. W. Price, and G. S. Dunn, escorted us to Schenectady. I might note here that although the special train was organised chiefly for the visiting members from Great Britain, Italy, and other countries, a number of well-known American electrical engineers with their ladies decided to take the round tour with us from New York to St. Louis and back.

ceived by President Coffin and other well-known men connected with the firm, among whom may be cited Messrs. Steinmetz, Lovejoy, Emmons, Rohrer, Hamill, Kruesi, Peck, M. P. Rice, Mullin, and Clark. Mr. E. Wilbur-Rice, Jr., chairman of the local Reception Committee, was unfortunately absent in Eurrpe. We were entertained to luncheon in the huge gallery of one of the new shops which had just been erected for turbine work. A number of circular tables were tastefully decorated with flowers and palms, and an excellent repast was served in a style that would shame some good-class restaurants. Following luncheon, the stupendous works were inspected, or rather run through,



BANQUET IN NEW TURBINE SHOP, GENERAL ELECTRIC WORKS.

I was sorry to lose the pleasant company of Mr. J. M. Wakeman and Mr. William Maver, junr., of New York, at Montreal.

Our train ran along the east bank of the Hudson River as far as Albany, presenting views, which excited considerable admiration, of the Palisades and of the Highlands of the Hudson. West Point, where, as is generally known, cadets are trained for commissions in the United States army, is situated on the west bank of the Hudson, about fifty miles from New York.

SCHENECTADY.

AFTER passing Albany, the train entered the beautiful Mohawk Valley, reaching Schenectady about 12.45, where the offices and great works of the General Electric Company are situated. Here we were received by President Coffin and other well-known men connected with the firm, among whom may be cited Messrs. Steinmetz, Lovejoy, Emmons, Rohrer, Hamill, Kruesi, Peck, M. P. Rice, Mullin, and Clark. Mr. E. Wilbur-Rice, Jr., chairman of the local Reception Committee, was unfortunately absent in Eurrpe. We were entertained to luncheon in the huge gallery of one of the new shops which had just been erected for turbine work. A number of circular tables were tastefully decorated with flowers and palms, and an excellent repast was served in a style that would shame some good-class restaurants. Following luncheon, the stupendous works were inspected, or rather run through, as the time at our disposal only admitted of a cursory examination. As we were leaving the grounds of the General Electric Company the signal sounded for cessation of work, and the thousands of hands employed by the Company poured out. The sight was a remarkable one, and there was a rush with cameras to points of vantage for snaps. Trolley cars were then boarded, and a trip taken over the Schenectady Railway to Ballston, where we had an opportunity of witnessing the new single phase-direct-current railway system of the General Electric Company. Our special train was waiting to take us up at Ballston. From Ballston we journeyed to Saratoga, reaching that place about seven in the evening, when dinner was almost immediately served at the United States Hotel. A couple of hours later we boarded the special again and left for Montreal.

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MONTREAL.

At 7.30 A.M. the next day, Wednesday, September 7, our special steamed into Montreal. Our headquarters had been made at the Windsor Hotel, a very fine building, with a splendid entrance hall. This and the spacious rooms and corridors are in every way well, not to say luxuriously, appointed. I do not know quite how it was, but I felt a little more at home as soon as I got inside this hotel. Perhaps it was because I was on British soil; anyway, everything seemed to appeal to me in a new light. The local committee, which had excelled itself in its efforts to make our visit a success, had provided tasteful badges, each of which bore a number corresponding with the wearer's name in the programme, and by this means the members were enabled to know each other's names without the embarrassment of inquiring. The local committee had also issued to every member a very neat programme in pamphlet form containing a map of the city.

A City of Great Possibilities.

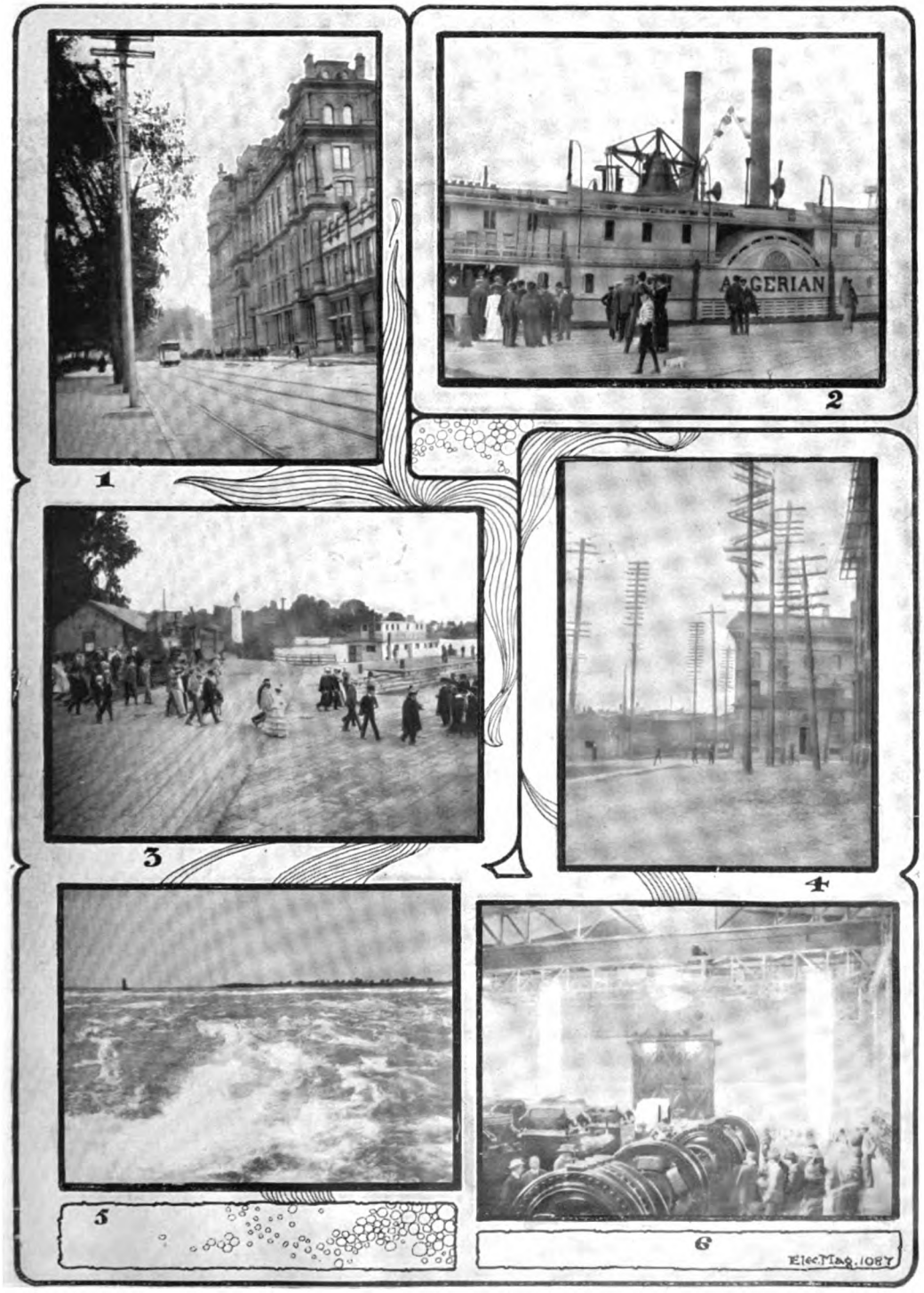
Montreal, the commercial metropolis and national port of the Dominion of Canada, is a city of 350,000, situated at the head of navigation of one of the greatest of rivers—a river which drains a most fertile and generous land. Montreal is undoubtedly destined to occupy a foremost rank among the cities of the American continent and of the world. The early history of the United States is inqissolubly blended with that of Montreal, for it was from this city that many of the strong men of one, two, and three centuries ago went forth to discover, to govern, to trade, and to convert. On St. Paul Street, which is east of Place Royale, stood the birthplace of Pierre and Jean-Baptiste le Moyne, the men who discovered the mouth of the Mississippi River in 1699, founded New Orleans, and who were, between them, governors of Louisiana for forty-six years. These facts appealed to me when I set foot in Montreal, and it seemed very appropriate that we should visit this city on our way to the St. Louis Exposition. I should like to dilate upon a great many of the other historical features of Montreal, but space will not permit.

When I looked at our official programme as I sat at breakfast in the Windsor Hotel, I realised how all too short was the time we had to inspect this city, in view of the programme we had to get through from 10 A.M. on the day of our arrival till our departure at 9 P.M. the next day, when we were due to start for Niagara. In that short period we had to cram in a number of visits and excursions, and I doubted if we could accomplish even this programme and see anything of the city at all beyond the immediate streets of our hotel. At 10.30 A.M., by the courtesy of the Grand Trunk Railway, we boarded a special train at Bonaventure Station for Lachine, on Lake St. Louis, nine miles from Montreal. At Lachine a steamer, *The Algerian*, was provided by the Mayor (Mr. Laporte) and Corporation of the City of Montreal, the luncheon on board also being provided by the municipality to the two hundred guests forming the party. The steamer was prettily decorated with bunting, and presented quite a festive appearance.

Down the Rapids.

As the boat left Lachine to convey us down the Rapids, Ald. Sadler, representing the Mayor of Montreal, made a bright and happy little speech from the pilot-house of the boat, in which he welcomed the electrical gentlemen to Montreal and to Canada. Canada itself could show, and would show, he said, considerable electrical improvement, and they had only to regard their waterways for a moment to reflect that there was an almost infinite possibility in regard to the generation of electrical power in their country. He wished us a merry time, and said nice things about the ladies, hoping we would see something which we would carry away with us in memory, and which would be found to be valuable, in regard to the possibilities of the new country which we had come to visit. Ald. Sadler's remarks were cheered to the echo. When the entrance to the Lachine Rapids was reached, the works of the Lachine Hydraulic and Land Co. loomed up on the left, and one of its leading officials, Mr. W. McLea Walbank, who was on board, gave us some interesting particulars.

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MONTREAL.

1. Windsor Hotel. ***2. The "Algerian" at Lachine.***
3. Leaving Lachine Station for the Steamer. ***4. Transmission Lines in Montreal.***
5. Lachine Rapids. ***6. Main Sub-Station of Montreal Light, Heat and Power Co.***

Photos by Messrs. Hayashi, Bates, Atchison, W. H. Scott and Pyne.

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Incidentally I gathered that Montreal was paying a good sum for its electrical power and light as compared with the cities of England and even of South America. According to the figures given by Mr. Walbank, Londoners were receiving their electric light and power at from half to two-thirds of what the same service is now costing Montreal. Weather conditions and the comparison in the price of coal would reduce this difference to some extent. Owing to the abnormal height of the water, the trip over the Rapids was not as exciting as usual, but all the same was very interesting and invigorating, and as the boat passed up Lake St. Louis I felt that a little more of this outdoor life would not be a bad thing. Everybody was delighted with the outing. Many cameras were used, and the ladies were enthusiastic. What was specially noticed was the great stretch of water, and it was easily recognised that Canada was a country of waterways and of the most tremendous possibilities. When the boat arrived at the end of Queen Street, at the foot of the Lachine Canal on her return journey to Montreal, the vessel was docked and the party disembarked and walked to the main receiving sub-station of the Montreal Light, Heat and Power Company, where tables were set around the machinery in the power room, which was buzzing away with a merry but very pronounced hum, oblivious of doing ought else but performing its work.

Man v. Machinery.

The setting was remarkably appropriate, and gave an added interest to the proceedings, the only disadvantage being that the speeches which followed the luncheon were scarcely audible, and in order to reach his hearers President Gray made a megaphone of his hands and shouted at the top of his voice. Even then he could not be heard by a number, amid the rattle and roar which was everywhere around us. Col. Henshaw, Vice-President of the Company, apologised for the absence of President Holt, and extended to us a warm welcome—in his own words, "a high-potential welcome." President Gray's remarks represented the feelings of the party. In the course of his speech, necessarily brief in view of the conditions, he said that he was attempting to convey very imperfectly the feelings he would like to express from his heart, and stated that we were very deeply interested in the systems we had seen. He added that we had found this a country of astounding projects and vast achievement, and should carry back to England with us feelings of friendship which we could not adequately express. Prof. Ascoli, on behalf of the Italian delegates, thanked the hosts for their kindness and hospitality, which he averred was deeply appreciated by his countrymen. Mr. Bion J. Arnold, rising for the American Institute, also using his hands as a trumpet, was somewhat amusing. In the course of his remarks he said: "This is the first time in my life that I have been placed in competition with an electric power-plant as a noise-maker, and it reminds me of the remark made by Chauncey Depew, who, when he was asked to speak to the guests of the Transportation Club over the 'phone from Washington, said, 'I have been often accused of making long speeches, but never before have I offended by making one 250 miles long.'" Col. Henshaw then proposed the King, and the assembly sang the National Anthem with enthusiasm. Afterwards, when the name of the Montreal Light, Heat and Power Company was broached, the entire company sang "For they are jolly good fellows." At the conclusion of the luncheon three special street-cars were in waiting, and we were taken about the city under the guidance of Ald. Sadler, as guests of the Street Railway Company, which had extended to us the privilege of riding free on the cars during our stay by merely exhibiting our badges to the conductors. Through the courtesy of the Bell Telephone Company also the local telephone lines were at the disposal of members on displaying badges.

At McGill University.

At 4.30 the majority of the party gathered at the Macdonald Engineering Building at McGill University, some ten minutes' walk from the Windsor Hotel. Here we were given a reception by the Chancellor, Professor Owens, and Governors of McGill. The building was decorated

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throughout with flags and streamers, and the refreshment tables were prettily adorned with flowers, whilst the orchestra played selections. We were received in the Architectural Room on the second floor by Mr. and Mrs. Frank Redpath, Mrs. C. J. Fleet, and Professor Owens (chairman of the local reception committee).

Up to this time the day had been fine, but as we left the university it commenced to rain, and things became a little unpleasant. It looked ominous for the garden party which was to be held at the beautiful grounds of the Forest and Stream Club, Dorval, between 8 and 9. The rain continued, but in spite of the unfavourable conditions a considerable number of our party took the special train from Bonaventure Station, which had been provided by the Grand Trunk Railway at 7.30 P.M. to Dorval, a resort on Lake St. Louis, some miles out of the city. I felt rather done up, and preferred to stay with other members at our hotel, which would give me an opportunity of committing some of my impressions of the journey to writing. It was past midnight when the party returned from Dorval, and I regretted to hear that the rain had greatly marred what would otherwise have been a most successful evening. Those who braved the weather were cold and wet, not to say muddy. I heard that the grounds of the club were decorated in a lavish manner with hundreds of Chinese lanterns. The club house itself was in festive attire, whilst an orchestra played on the eastern verandah. The members of the local reception committee, and particularly the painstaking secretary, Mr. H. D. Bayne, were worthy of every praise for their efforts.

Surprised by Indians.

The feature of the evening was a surprise, being the arrival of some twenty Indians from Caughnawaga, who came over in canoes, and entertained the visitors in a novel manner, giving the ancient Iroquois war and spirit dances, marriage ceremony, and battle and death songs. By special request of Mr. Walbank, of the Light, Heat and Power Company, whom they term their White Chief, the Indians sang the National Anthem in their native tongue. Fireworks were sent off on the lake, and refreshments were served in a large marquee in the rear of the club.

At 8.30 the next day, Thursday, September 8, special street-cars were in attendance at the Windsor Hotel to convey us to Moreau Street, where a special train of the Great Northern Railway Company of Canada was in readiness to take the party to Shawinigan Falls. Only about half the members took this journey, others preferring to visit the city. I went to Shawinigan, and didn't regret it. I think many members were very sorry afterwards that they had not taken the trip. I hope I am not drawing invidious comparisons when I say it was about the most enjoyable and interesting day I spent whilst on the tour.

Shawinigan—a Gem of Nature.

The Falls are some seventy miles from Montreal, and the journey was full of incident, passing through the most beautiful scenery. The maple was in its prime, the leaves turning from golden brown to a glorious red. The foliage and scenery along almost the entire route was truly magnificent. Somewhere about midway between Montreal and Shawinigan we came to a bridge which spanned a deep gulley. Here in the centre of the bridge the train stopped to allow the members to inspect the surroundings. Immediately on the right was a beautiful cascade, the Mackingol Falls, dancing and foaming over large boulders from a considerable height. We were told that this was a miniature Shawinigan, and we were all the more anxious to see the real thing. Whilst some members were at a distance from the rear of the train taking snapshots, the stentorian voice of one of the officials shouted "All aboard," and there was the usual rush. I am told that I was nearly left behind, at all events the train was well on the move when I was hauled on board into the centre of an excited party.

Making Calcium Carbide.

We next made a stop shortly before reaching Shawinigan, to inspect the Shawinigan carbide factory there, and to witness the very interesting process of manufacture. The furnaces were of the latest type designed to facilitate the easy

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removal of the finished product. The carbide is very hard after being taken from the furnace, and has to be treated with pneumatic chisels before being dealt with by ore crushers. The scale, which is very refractory, requires considerable labour and force in its removal, and we were much struck with the efforts of the men in this direction. The shutters of the electric furnace were raised to allow us to observe the burning arc, which was reducing the raw material to its ultimate solidified condition, whilst huge banks of the manufactured article turned out of the furnaces were piled up here and there, giving off a tremendous heat and that peculiar smell which is so nauseating to most people. This factory was in every sense a model one of its kind, but all the same I pity the men who have to work in such an industry. There are many silent heroes in peace as well as in war. Leaving the carbide works we again boarded the train and arrived at Shawinigan shortly before noon. We were received at the station by Mr. J. E. Aldred and Mr. Wallace, the courteous secretary and chief engineer of the power company respectively. We were then conducted up the slope of a hill on which stood a picturesque hotel among the trees, where refreshments were served in two or three rooms, there not being a room large enough to accommodate the whole party. It was almost an *al fresco* luncheon, taken on our laps and finding a seat anywhere, some members betook themselves to the verandah others were outside among the long grass and reeds. Altogether it was most enjoyable, and after cigars had been handed round the party (who, on taking a great fancy to the beautiful crimson maple-leaves which adorned the refreshment buffet, were invited to take them and responded by not leaving a single one) proceeded to the Falls.

A Magnificent Cascade.

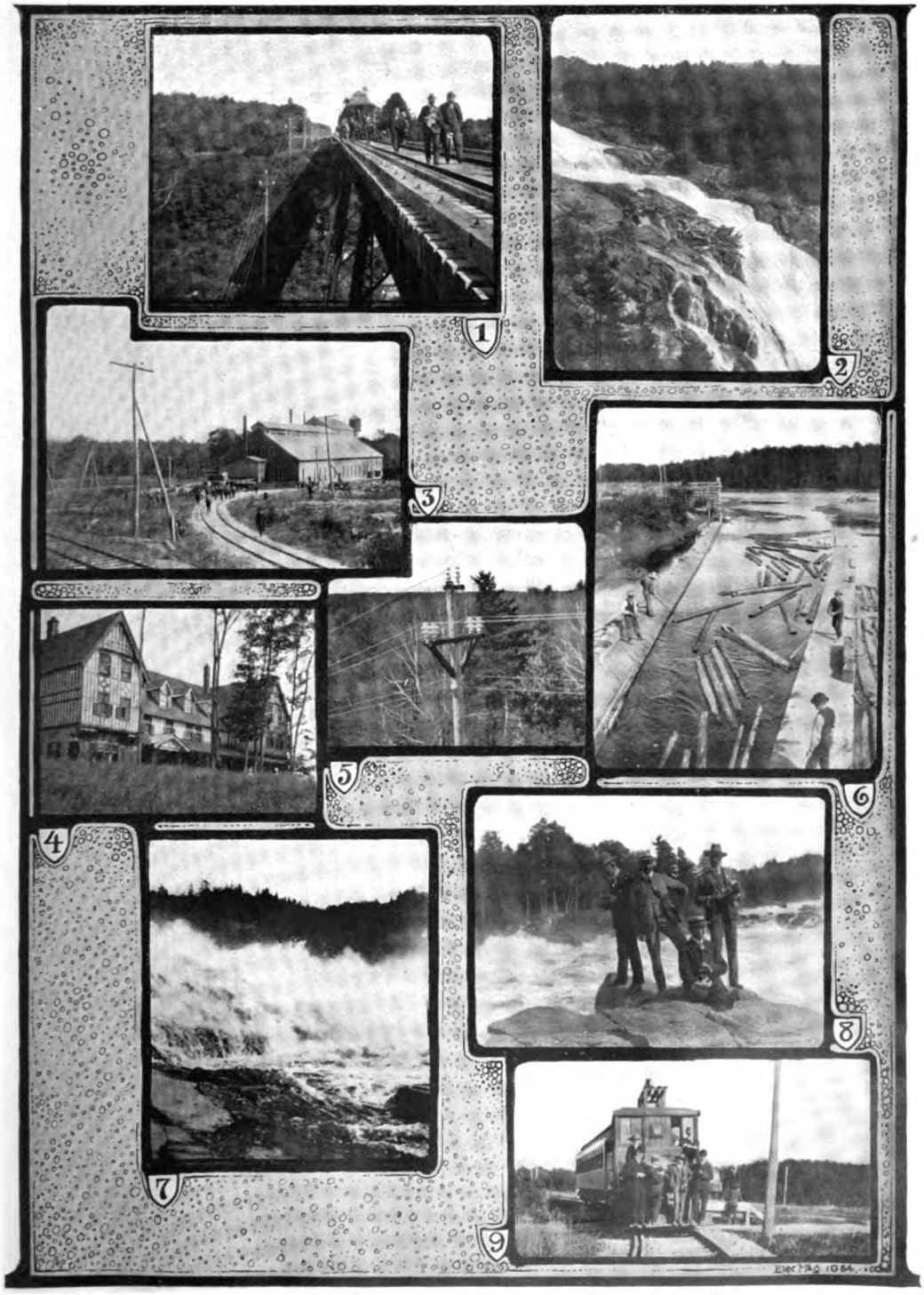
I have never seen a more beautiful sight than this mass of water tumbling in a series of cascades over the huge boulders, down, down and down through the long valley, flanked on either side with magnificent fir and other trees. It hasn't the drop of Niagara, but is infinitely more pretty. One could have stopped a week there in admiration of the thousand and one beauties that presented themselves to the eye at every point. Some of our party were rather hazardous in their endeavours to take pictures, and I should say that there were more films and plates used on this afternoon than at any time on the tour. I do not know whether I took greater risks than any of the others, or whether I lack that sureness of foot which so characterises the gazelle, but I found myself on one occasion several feet beyond the spot which was considered a safe landing-stage, with my camera in one direction and my walking-stick in another; and my position, as I tumbled over a ledge of rock, anything but a dignified one. I am told somebody had a picture of this incident, I believe it was Mr. Sheardown, of Dublin, but anyhow he has written me since to say that by some apparently unaccountable means his films melted in development!

The Power House.

Leaving the Falls, down a winding and sloping glade, we reached the power house, the entrance to which was through a long passage running alongside the pipe lines. We were courteously conducted through by the officials of the power company, who explained to us everything we wanted to know. The more particular features of this power house are given elsewhere. At four o'clock we took train for the return journey, reaching Montreal about 7.30, after one of the most enjoyable and memorable trips possible, undertaken under absolutely ideal weather conditions—glorious sun, silurian blue sky relieved with patches of snowy white cloud, and a gentle breeze.

Those who did not undertake the visit to the Falls were entertained by Mr. H. D. Bayne, secretary of the Montreal Reception Committee, who took them in the morning through and about the city to Mount Royal Park in thirteen four-in-hands, and to the grounds of the Montreal Hunt Club, a few miles outside the city. I am told that this drive was through the most beautiful scenery, and was greatly enjoyed by the participants. After luncheon the party was transported to the McGill University buildings, and the various power houses and sub-stations of the Montreal Light, Heat, and Power Company, the Shawinigan Water and

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SHAWINIGAN.

1. Stopping to inspect the Maskingoe Falls. *2. The Maskingoe Falls.*
3. Carbide Works. *4. Where the Party Lunched.* *5. 50,000 Volt Transmission Line.*
6. The Lumber Chute. *8. Messrs. Hesketh, Taite, Sheardown and Feilden.*
7. Shawini_an Falls. *9. The Return from Shawinigan.*

Photos by Messrs. Atchison, Hope-Jones, Morse, Taite and Barnes.

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Power Company, and the Montreal Street Railway Company. The power house of the Lachine Rapids Hydraulic and Power Company was also open during the afternoon and inspected by a number of our members who reached them by taking the Wellington Street cars.

At nine the same evening our special left the Windsor Street Station of the Canadian Pacific Railway for Niagara Falls.



NIAGARA.

OWING to the limited number of days accorded to us to "do" America, a number of what would otherwise have been our most interesting railway journeys were taken by night. I regretted not to have had the trip from Montreal to Niagara in daylight, but to do the thing properly one would have wanted as many months as we had weeks, at the least. When morning broke we found ourselves nearing the world-famed Falls, and after leaving Buffalo the whole party was pretty well agog with excitement. Intense interest was manifested in the Niagara River, which is very rapid at the foot of Lake Erie. As it broadened out downstream, exhibiting the features of its development, the interest was intensified. The train arrived at Fall Street Station at 10.30, an hour and a half behind time.

Electric cars were waiting to convey us round the Niagara Belt Line, which the local reception committee, headed by Mr. George W. Davenport, had provided for us. Before the great lines of electric traction were established at the Falls it was impossible to gain access to the many points of interest that are now reached by the admirable trolley system encircling the great gorge, and for a distance of over twenty miles continually presents an ever-changing panorama of beautiful scenery.

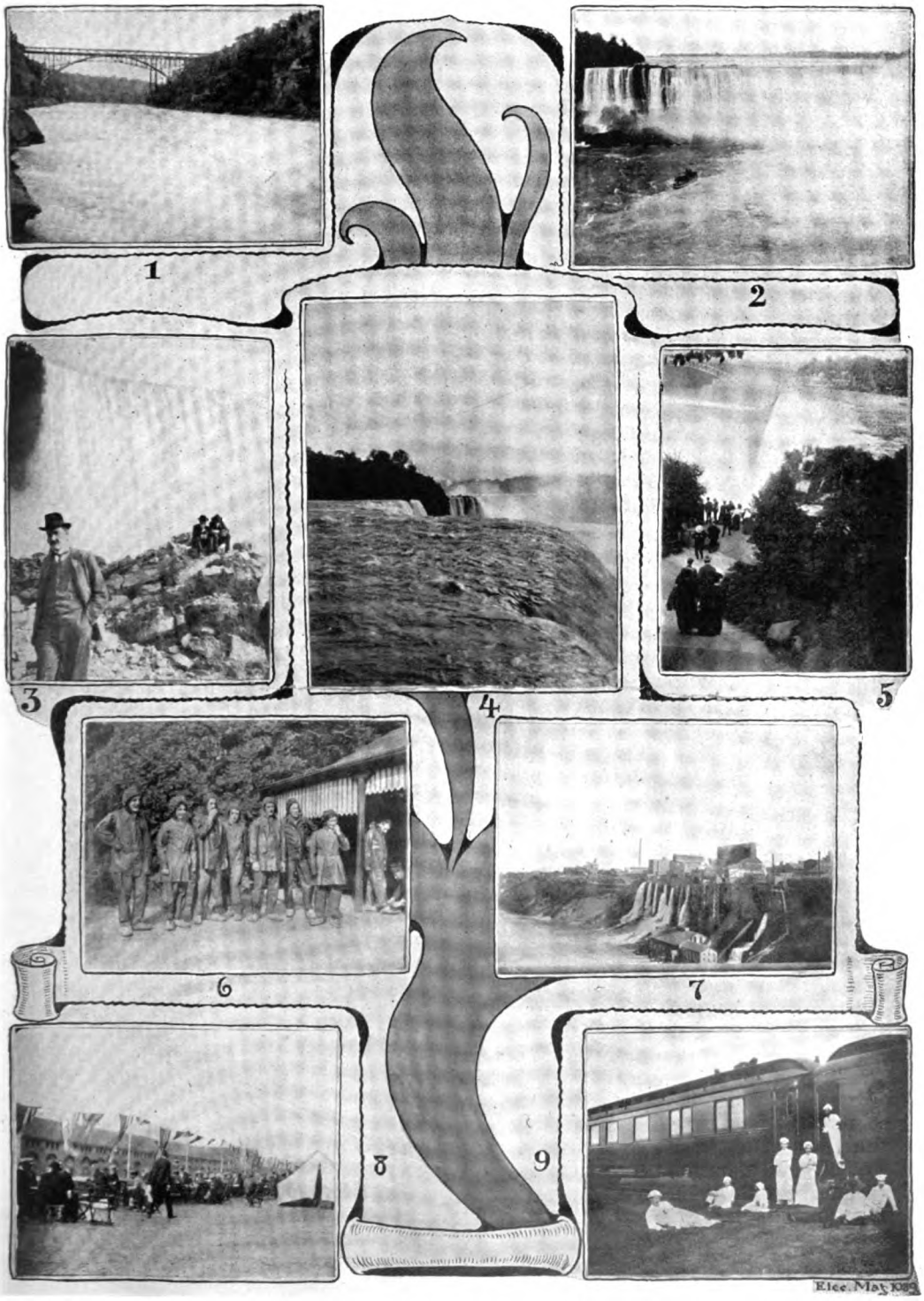
Down the Gorge.

We started from the American side to Lewiston, across the gorge by the lower suspension bridge to the Canadian side. This was perhaps not the best way to go, as we were running with the river, and being on the inside track our view was impeded once or twice by cars on the outer side. Our journey was a revelation, however; one series of panoramic views of wondrous nature. The scenic effects along this magnificent gorge baffle description, the car passing on amid scenes of imposing grandeur by a winding course following the contour of the river-bank. A turn in the river and the great Whirlpool Rapids suddenly loomed into view, churning, foaming, and tossing, and forming a scene that riveted the attention, exciting awe and admiration. Here and there on the journey we were enabled to see the Falls in the distance, all with some new and increased interest. Stopping for a few minutes at the spot where Captain Webb met his death in the Rapids, and again at the great whirlpool, of which many photographs were taken, we were carried to the lower suspension bridge across the end of the gorge, where a splendid view of Queenston Heights was presented. Proceeding over the suspension bridge to the Canadian side, our car ran against the course of the river to Victoria Park, where we alighted. At the very least a day should be taken on this trip around the Belt Line. To come thousands of miles for a two hours' inspection seemed almost sacrilege. Something like half an hour only was available to inspect the works of the Canadian Niagara Power Company, the Ontario Power Company, and the Toronto and Niagara Power Company, which were all in course of construction.

Great Power Developments.

At the time we were there the wheel-pit of the last-named company was being sunk, the big steel flume of the Ontario Power Company was nearly completed, and the plant of the Canadian Niagara Power Company was sufficiently advanced to justify our guide informing us that it was expected 50,000 h.p. would be available by January of the present year. This power house is arranged on lines similar to those of the American power-plants. It is an allied power development, consisting of eleven generating units of 10,000 h.p. By means of interconnecting cables between this Canadian power house and the two houses of the Niagara Falls Power Company power can be transferred from any of these three allied plants to either or both of the others, so that power-users supplied from each will have ample reserve to guarantee continuity of power service. Returning

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NIAGARA.

1. The Rapids. *2. "Maid of the Mist" and the Falls.*
3. Dr. Glazebrook at the Falls. *4. At the top of the Falls.* *5. Canadian side.*
6. Preparing for the "Cave of the Winds." *7. The Waste of Water.*
8. Refreshments at Power House, No. 2. *9. Our Cooks.*

Photos by Messrs. Morse, Hope-Jones, Longbottom, W. H. Scott, Pyne, Atkinson and Barnes.

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from a cursory inspection of the Canadian power houses, we boarded a car to take us over the great steel arch-bridge spanning the Niagara River a few hundred feet below the Falls. As the car slowly moved over the bridge one of the grandest and most perfect views of the Falls was gradually unfolded, and the stupendous mass of falling water in its mighty grandeur appealed more than ever to the members of our party. Whilst I cannot be accused of any want of progressiveness, I looked with regret upon the power houses and factories which were spoiling this grand spot of God's creation. At one point nothing incongruous was in evidence, but on turning, the unmistakable evidence of industry frowned upon romantic nature from which it now draws its sources of power, and the scene was marred. One thing was animadverted upon, and that was the great waste of water which was apparently going on, hundreds of thousands of tons running away from the factories as pictured on page 37. It struck more than one of us that this could be turned to good account before its return to the river.

The turbulent rapids above the Falls are well worth a journey. It is a sight to see the wild and plunging waters in their mad rush before leaping into the chasm.

Arriving at the International Hotel, on the American side, luncheon was served at one o'clock by the local committee. Following luncheon, the members of our party were left free for an hour or two to do as they willed. Some took the little steamer *Maid of the Mist* to and from the Horseshoe Fall. Others tried the experience, in appropriate costume, of a visit to the "Cave of the Winds," I had not an opportunity of this unique experience, as my time was taken up in photographing the Falls from various points of vantage, and I had an interesting interview with the lady who went over the Falls in a barrel. The time was all too short for this visit to Niagara; it was impossible to see a tithe of what one would have liked.

In the Pioneer Power Houses.

I had scarcely half an hour to visit the great power house, No. 2, of the Niagara Falls Power Company. Every courtesy was shown us by the officials of the company, and facilities afforded for a thorough inspection. This place is weirdly impressive. It gives one almost an uncanny feeling to gaze at the battery of squat-looking machines of power which do such tremendous work in so silent a manner. A number of the party visited the Niagara Falls Hydraulic Power and Manufacturing Company, but it was impossible for one man to do both places. On the conclusion of the all too brief inspection the members came together on the terrace over the forebay structure, where light refreshments were provided. The terrace was tastefully draped with the Union Jack and Stars and Stripes. I had many introductions here, and a very interesting chat with Dr. Coleman Sellars, the chief engineer, who was the centre of an admiring group. On the sounding of a bugle at 5.50 P.M. we were warned that time was up, and we found our special train had been run right down to power house No. 2 over the Niagara Junction Railway. This, I was informed, had never been done before, and it gave us, I imagine, quite half an hour longer than we otherwise should have had. Within a few minutes we were all aboard, and with many handshakes and farewells we were carried to the Fall Street Station, leaving there directly after six for Chicago. Rounding a bend in the line as we left Niagara, a beautiful view of the Falls was presented, and the train stopped for a last inspection. Dinner was served in the dining-cars soon after the departure of the train. Another night in the train—not an unpleasant experience, as the comfort accorded enabled one to sleep as soundly as in any hotel—and at 7.30 the next morning we found ourselves steaming into the Central Station of the great packing city of the West.

CHICAGO.

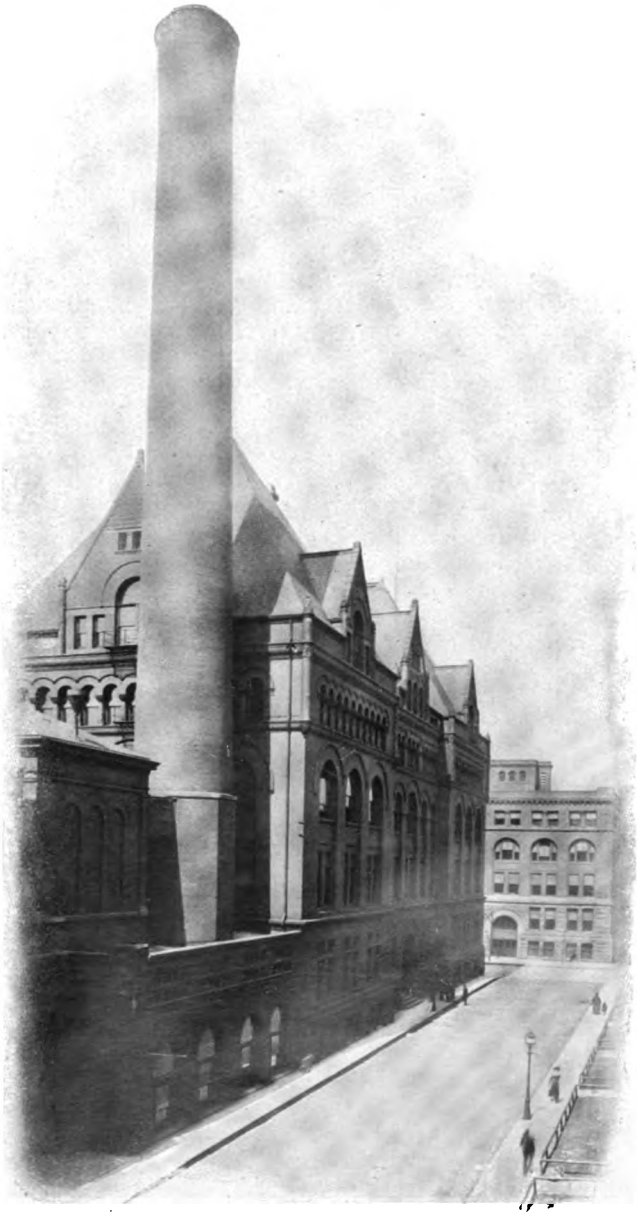
THE Chicago Local Reception Committee sent on two of their representatives in advance to Niagara, and on the way to Chicago they gave us a welcome, and handed to each member an engraved invitation to become their guests. As we only had the day at Chicago and there were quite a number of places we were invited

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to visit, we were each provided with a copy of the programme, with an intimation that we should indicate our choice of places respectively on a card which could be detached. The entire parlour floor and a number of rooms had been engaged for our accommodation at the Auditorium Annexe, a very fine hotel facing Lake Michigan. After breakfast, which was given by the local reception committee and served in the Palm Room of the hotel from 7.45 to 9 A.M., we were invited to take motor-cars for the respective trips we had selected, and about fifty automobiles were in attendance outside the hotel.

Electrical Sights.

The programme arranged for our entertainment was as follows: In the morning, as general tours, a visit to the Fisk Street station of the Commonwealth Electric Company and an inspection of the main exchange of the Chicago Telephone Company's building at Washington and Franklin Streets. Special tours had also been arranged to start at the same hour, viz., 9.30, to points of particular interest to parties of three or four or to individuals, to the following: Automatic telephone exchange and underground tunnels of the Illinois Tunnel Company; Western Electric Company's manufacturing establishments; Chicago Edison Company's Harrison Street generating station and some typical sub-stations; the Union Loop and elevated railroad system; the electric elevator and general motive power installation in Marshall Field and Company's retail stores and the Deering and McCormick branches of the International Harvester Works. A great many of the party went to the Fisk Street station to inspect the three 5,000-kw. turbo-generators working there. This station is designed for an ultimate capacity of 100,000 kw. About an hour was given up to this visit, and the party then travelled north and east, passing the Western Electric Company's factories and one of the Chicago Edison Company's distributing stations on the road to the Chicago Telephone Company's building. Leaving



MAIN BUILDING, ARMOUR INSTITUTE OF TECHNOLOGY.

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this place the visitors joined the main party at lunch at the Auditorium Annexe at 1 P.M. In the meantime other members of the party, with the exception of a few who had been paying visits in the city, had been on the special tours selected. Favour was given more particularly to the tunnel system, where an opportunity was given to study the modern method of electrical transportation underground which was being installed beneath the business streets of Chicago.

The general tour for the afternoon consisted of a short cruise on Lake Michigan on board the U.S.s. *Dorothea* along the west shore of the lake, which gave an excellent view of the city, its water front and lake shore drives. The special tour consisted of an automobile trip through the South Side Park system, starting at 3 P.M. and returning at seven. I undertook this latter, and in company with Mr. and Mrs. Bates, Mr. Sheardown, and one of the courteous members of the reception committee, had a splendid run down the magnificent main avenue through the Park, past the old show-ground of the Chicago Exposition, stopping at the German Pavilion, which had been preserved intact, and back to the hotel. Chicago has a magnificent park, beautifully laid out and cared for, and though it lacks the natural scenic effects of Boston, it is nevertheless a park to be proud of.

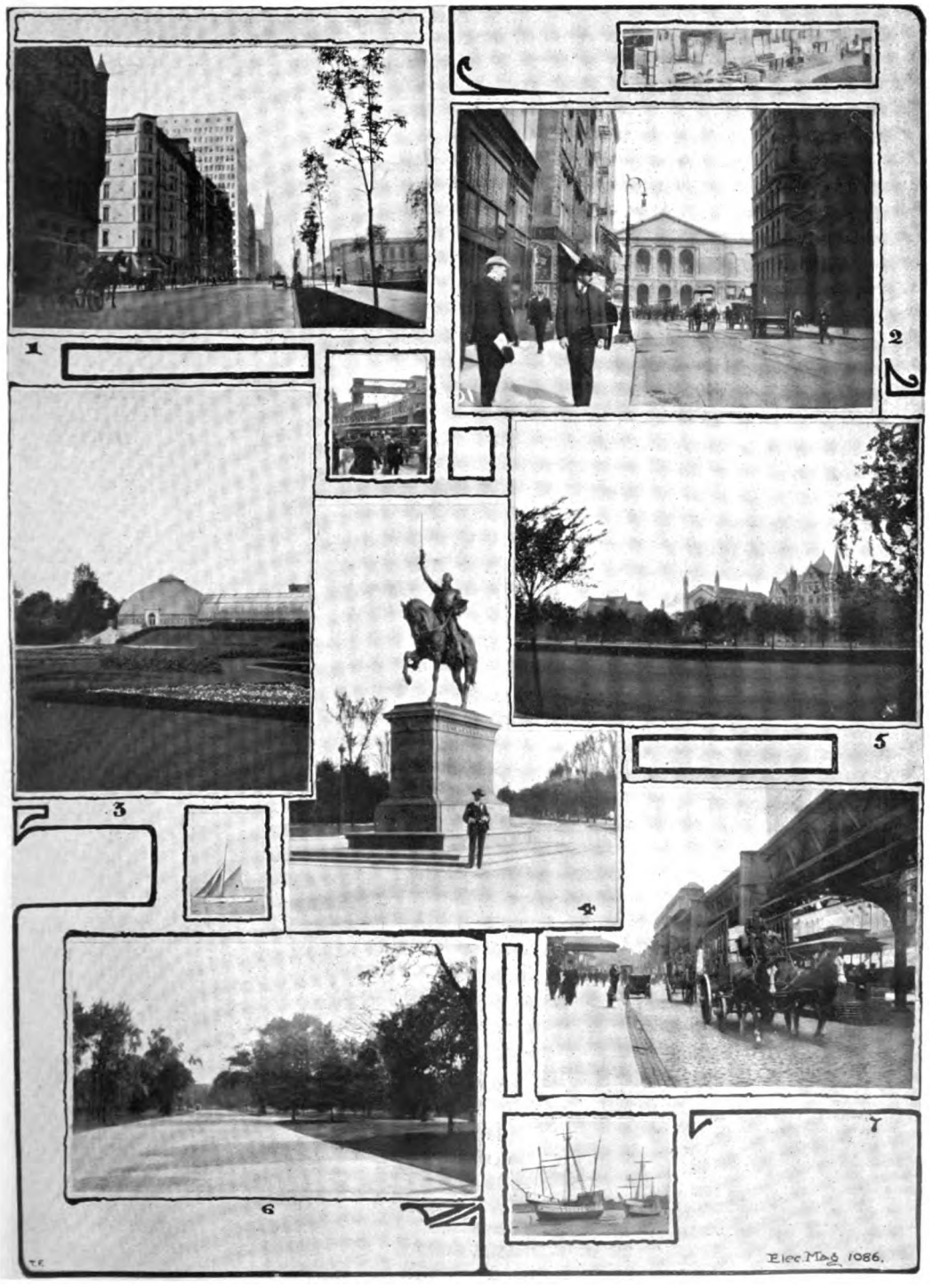
A Memorable Gathering.

Dinner had been fixed for eight o'clock in the Palm Room, which was prettily decorated for the occasion, a mass of lovely cream roses being in evidence on the tables. The dinner had been thoughtfully arranged in an informal manner, as the reception committee naturally judged that we should be fairly tired and that there would be little or no time to dress. There were therefore no set speeches. On the conclusion of the dinner, Mr. Samuel Insull, the Chairman of the local committee, voiced the sentiments of his colleagues in expressing the gratification he experienced at the visit of the British, Italian and other engineers to the city of Chicago. President Gray, in responding briefly, gave it as his opinion that these meetings were of incalculable benefit not only to the cause of manufacture but to the welfare and peace of mankind, as we were cementing good relations and making friends everywhere. Such gatherings augured well for friendship between the countries of the world. Col. Crompton emphasised the intense pleasure it gave us to visit the great continent of America, and to be received from one end of the land to the other in such a warm manner. He expressed our sentiments when he said that he felt we had known our good hosts such a long time that we almost considered Britain and America as one. Other remarks of appreciation were made by Professor Perry on behalf of our Institution, and Professor Ascoli for the Italians. President Arnold and Mr. Lieb likewise tendered a few appropriate remarks on behalf of the American Institute of Electrical Engineers. A pleasing episode was the singing of the national anthems of the countries represented by the members present, finishing up with "Auld Lang Syne." It had been a day full of incident, I might say with truth, strenuous effort, but it had been enjoyed to the full. The utmost thanks of our party were due to the indefatigable Chairman of the committee of arrangements, Mr. Insull, and to his associates, Messrs. A. S. Hibbard, George A. Damon, Frederick Sargent, and Peter Junkersfeld, for the way in which they had provided for our entertainment.

A Pleasing Duty.

I had a special commission to perform whilst in Chicago, and diverted from the official programme in the morning in order to carry out the duty which lay before me, which consisted of placing in the hands of Dr. Gunsaulus, the Principal of the Chicago School of Technology, an old Shilling Bill, issued by the Revolutionaries in the War of Independence, and which Mr. Thomas Graham, J.P., of Wolverhampton, England, one of the directors of the Electrical Publishing Company, Ltd., had secured and desired to present to the Chicago Institution. I paid a visit first of all to the superb offices of Messrs. Armour, and there had the pleasure of meeting the manager, Mr. Evans, who, ascertaining that Dr. Gunsaulus was waiting to see me, with a hearty handshake and kindly sentiments expressed the desire that I should inspect the Institution. In order to effectively

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CHICAGO.

1. *The Auditorium Annexe.*
2. *Street facing Art Gallery.*
3. *In the Park.*
4. *Statue of Washington.*
5. *Chicago University.*
6. *Drive in the Park.*
7. *Traffic Contrasts in the City.*

Photos by Messrs. Barnes, Taite, Bates and Hayashi.

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carry out this little programme the reception committee had kindly placed at my disposal an electric run-about, which carried me to the world-famed Institution. Dr. Gunsaulus received me in the manner which is characteristic of him. No wonder that he is respected and admired. At the time of my visit the Institute was not in session, but the officials were all busily at work, and I had the gratification of being introduced to them one by one and escorted through every room of the splendid buildings.

On leaving, Dr. Gunsaulus requested my acceptance of his autograph portrait, and wished me to convey a message to my English friends at home that he would be happy to give every facility at any time for gentlemen from the old country to inspect the Institution over which he so ably presides.

Impressions of Chicago.

I would have liked to have visited the stock yards, but Mr. Evans had told me earlier in the day that the great strike, which had only just been arranged, made it inadmissible. A reign of terror had existed for some little time in the yards, revolvers being the order of the day. The only evidence I had of the stock yards was conveyed to my olfactory nerves by a wind that was blowing across therefrom in the direction of our hotel. This, as the day was somewhat sultry and humid, was not exactly pleasant. As to the streets of Chicago city proper, I felt that there was no place in the States I would less like to live or have my business quarters in. Some of the roadways are atrociously kept, and I tripped into deep holes on more than one occasion. The streets are mainly of the large cobble-stone order, and liberally sprinkled with ruts—near the tramlines miniature ravines. What with the cars which meet one at every turn, the heavy and noisy traffic, and the overhead lines, Chicago is not an ideal city for the average man with nerves, but it has its grand avenue running for miles on and beyond the shore-line of Lake Michigan and its beautiful Park, and that makes up for a lot.

Leaving Chicago by special train from the Illinois Central at 11.45 P.M., and again travelling all night, we reached Springfield, Illinois, on Sunday, September 11, at 7.30 A.M.

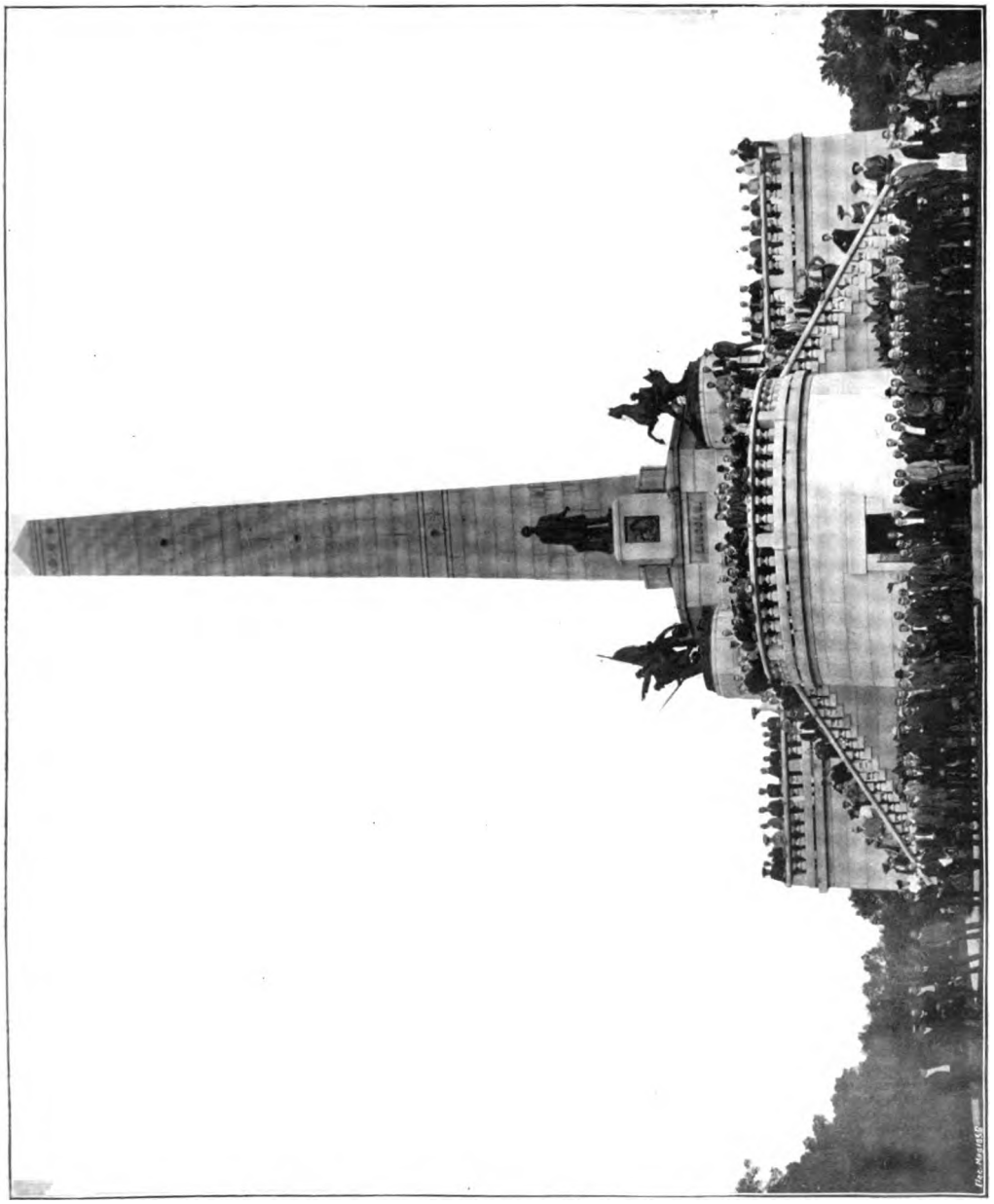
SPRINGFIELD.

THIS stop on the road to St. Louis was made in order to visit the tomb of President Lincoln. Breakfast, given by the Citizens' Association, was served at the Leland Hotel, about seven minutes' walk from the station, within a quarter of an hour after the arrival of the train. Not a moment was lost. Breakfast over, trolley-cars took us to Oak Ridge Cemetery, a beautiful spot, on an eminence in which stands the splendid monument erected by the nation to the martyred President. A short time was spent in inspecting the tomb, containing the precious relics of the President's life, many of them of a deeply interesting character. Addresses of welcome from the steps of the monument were then given by the Mayor of Springfield, by Governor Richard Yates of Illinois State, and Chairman Ridgeley, of the Citizens' Association.

The Governor's Address.

Governor Yates' address was delivered with that eloquence which is so characteristic of the practised American orator. It was impressive, not to say inspiring, and was listened to with rapt attention. The Governor, in the course of his remarks, said that he was almost afraid to face an audience of electricians. He did not know what they might do. There was something so mystical, almost uncanny, about electricity that made him think that when he was talking to an electrician he was conversing with a wizard. "You are the men," he said, "that our martyred President described as those 'who did things.'" The Governor dwelt upon the life and character of Abraham Lincoln in a manner which carried conviction to the ears of his listeners. He hoped that with all their achievements, their work would be accomplished as Lincoln's had been—with malice towards no one, with charity for all. The Governor told the gathering that he had visited Great Britain and Europe, and had discovered that there were other people on the face of the globe besides Americans; and the feeling he held was that the world would be

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At Lincoln's Tomb—An Historic Incident.

richer by such meetings as these, in which even the friendly rivalry of commercial competition was for the time being stifled, and the hand of friendship grasped with a sincerity which was unmistakable and which tended towards the peace and progress of mankind. Presidents Gray, Arnold, and Ascoli briefly responded for their respective Institutions, after which the whole party was officially photographed on the steps and balcony of the monument. After an introduction to Governor Yates and other gentlemen, I followed the party down the slope from the monument back to the train. On arriving at the station, I had

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ON THE STEPS OF LINCOLN'S TOMB.

placed in my hands by Mr. John H. Nehr, President of the Business Men's Association of Springfield, an aerogram from St. Louis, with a request that it should be read to the members of our party. It was a message from the American De Forest Wireless Telegraph Station at the World's Fair, and was as follows: "Will be pleased to place our wireless telegraph system at the command of the visiting electrical engineers who will be with you to-morrow, and trust that while in St. Louis they will visit our stations and observation tower on the World's Fair grounds, and would also be pleased to give a demonstration of our system's practical working at any time they wish.—ABRAHAM WHITE, President, American De Forest Wireless Tel. Co."

The train was off within five minutes of our reaching the station, and at two o'clock, after passing through some interesting but not overwhelmingly grand country, we arrived in the city of the World's Fair.

ST. LOUIS.

ON arriving, we were driven in single and two-horse conveyances to the Jefferson Hotel, where the majority of the members were quartered. A reception was held by the local committee, headed by Mr. W. V. N. Powelson, who gave us a hearty welcome.

The Jefferson Hotel is a sumptuous building, and apparently every effort had been made to accord us the maximum degree of comfort whilst on our stay, although I must confess that I was not prepared to take a half-share of a bedroom, particularly at the princely rates we were paying. I found it was unavoidable, however, and many other members were similarly placed. There was not a single bedroom to let in the huge hotel, the size of which can be best appreciated by a glance at the snapshot on opposite page. Most of the American hotels have magnificent halls on the street-floor, and the Jefferson Hotel rather excelled a number of the others we had been quartered at. It had a somewhat majestic appearance, the ceiling being supported by large Corinthian pillars—marble, I believe, as far as my recollection serves me. The ceiling itself was practically a work of art in plaster, and the lighting arrangements were excellent. On either side of the entrance-doors, immediately on entering, were the telegraph-offices. At the end of the spacious hall, facing the doors, was the registration and inquiry department. Next to this was the mailing department, and opposite the counter of this department was the newspaper and magazine depôt, at which all the latest publications were exhibited. This place also served for the sale of pictorial postcards. In and around the big hall were seats and lounges of every kind.

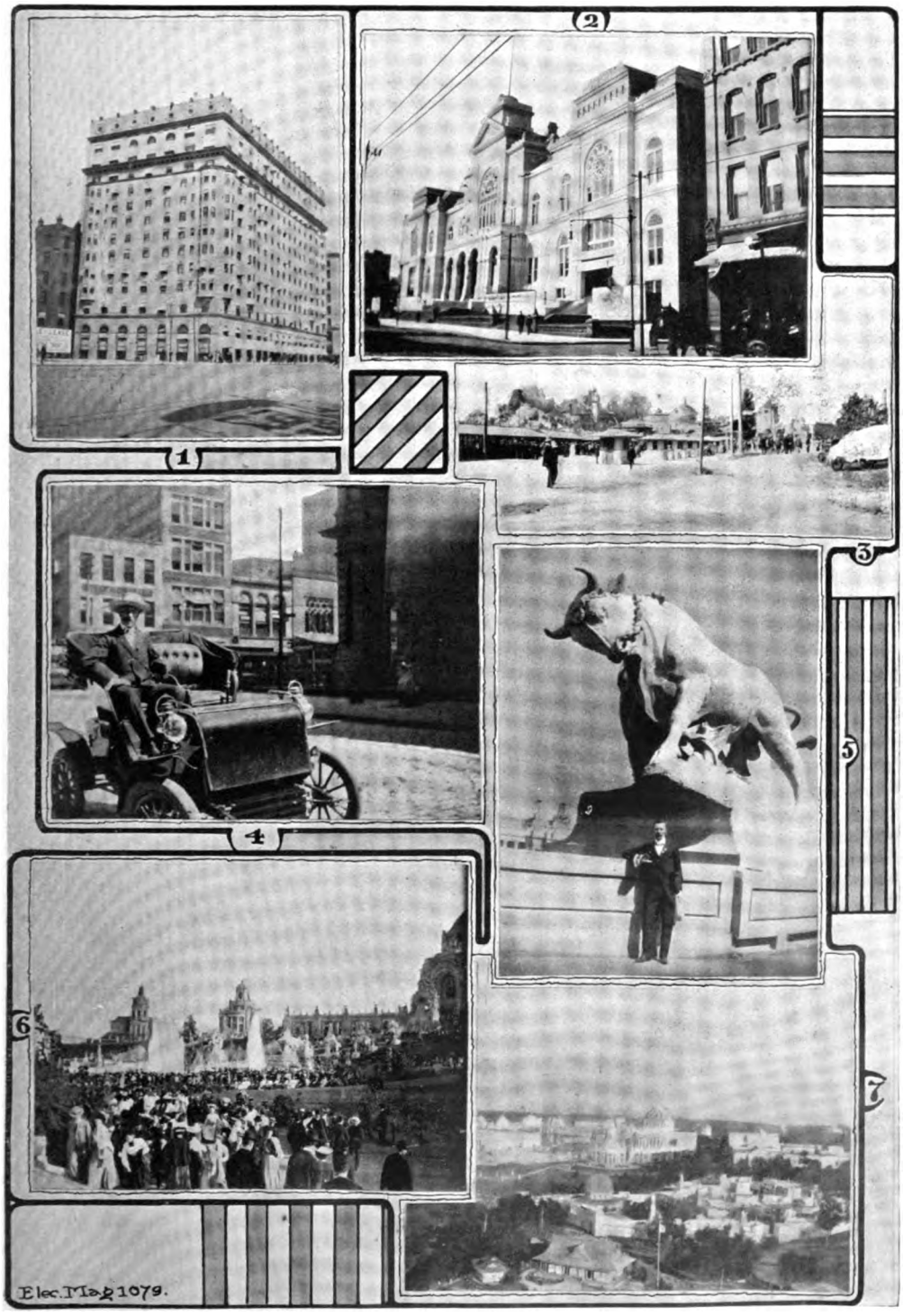


W. V. N. POWELSON.

Luxurious Quarters.

Handsomely appointed writing and retiring-rooms were to the left and right of the hall, whilst less luxurious but more utilitarian commercial writing-rooms were

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ST. LOUIS.

1. Jefferson Hotel.
2. Congress Hall.
3. Entrance to Exposition.
4. Paying Calls at St. Louis.
5. Top of Festival Hall Steps.
6. St. Louis Day.
7. General View of Exposition.

Photos by Messrs. Feilden, Barnes, Marshall and Atchison.

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FESTIVAL HALL AND LAGOON, ST. LOUIS DAY.

placed on balconies over the inquiry and newspaper departments. Great dining-rooms flanked each side of the hall, from which radiated reception-rooms of various sizes and a commodious buffet. The telephone installation in the big hall was on a most complete scale. Down a large flight of marble stairs one is brought to a series of spacious rooms on the basement-floor, the chief being a large supper-room. This hotel, as many other of the chief hotels in the States, contains below-ground a very large toilet establishment, where something like twenty to thirty barbers are constantly engaged, and as many other attendants are actively employed in various avocations.

But very few of our party on this day of arrival travelled out to the Exposition, which was situated several miles from the city and could be reached by two lines of trolley-cars. Everybody was very tired, and glad to rest.

At 9.30 the next day (Monday, September 12) the International Electrical Congress convened at the Music Hall of the Coliseum at Olive and Thirteenth Streets, within five minutes' walk of the Jefferson Hotel. Over eight hundred members of the Congress from all parts of America and abroad were in St. Louis prior to our arrival, and the best part of a thousand assembled at the Hall of Convention. The proceedings are treated upon in another part of this issue under congress matters, and there is therefore no necessity for me to deal with them here. A large number of our party who had previously omitted to join the roll of membership, myself among the number, took advantage of the presence of the officials to register and to secure numbers and badges.

An Emblem of Peace.

The Congress badge, in the form of a pin, was somewhat unique, being a bronze-coated head of Pax with the inscription "International Electrical Convention, St. Louis, 1904," thereon. From

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the medallion a small piece of white satin descended, bearing the registered number of the member. By this time many of our party were very highly decorated, a number of the members preferring to exhibit the whole of their badges. At 1.30 the sections which had been holding their meetings in the halls on the second floor of the Coliseum adjourned for luncheon, after which the majority of the party proceeded to the Exposition. Previous to taking car for the World's Fair I paid a visit to the main streets of St. Louis, with the object of becoming a little acquainted with the city. St. Louis can boast some very fine streets and business establishments. Huge stores abound, on a similar scale to those in New York; and, owing to the system of placing the streets, largely adopted throughout the cities of America, there is little or no difficulty in finding one's way about. A large number of the buildings, such as that of the Missouri Trust, are palatial. The newspaper offices are likewise on a big scale, and conducted on lines which do not admit of a moment's waste of time or effort, whilst there is a conspicuous absence of apparent "hustle." It is, however, going on all the time without undue haste or anxiety. I think Americans score over us in the calm and deliberate way in which they go about these matters: to use one of their phrases, "they get there every time," securing a maximum of result with a minimum waste of energy and brain-tissue. This may contrast strangely with the generally accepted idea that Americans are wearing themselves to death at the pace they go. This is probably true of a considerable section of the community, particularly those who gamble in stocks and shares and those who pursue avocations where an unnatural excitement is constantly kept up. But I am assured that the engineers and newspaper men of the United States will live as long as, if not longer than, the men following similar professions in Great Britain or any other country,



NIGHT VIEW OF EXHIBITION SHOWING ELECTRICAL ILLUMINATIONS.

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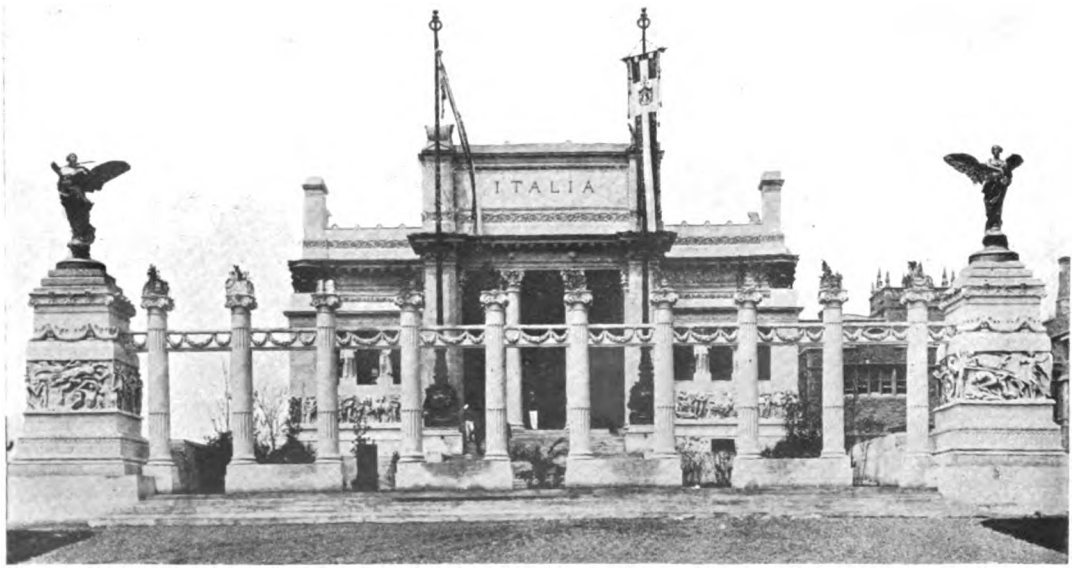


THE BRITISH PAVILION.

and I consider that their achievements are consummated far more quickly than ours, not so much by reason of the fact that they rush through them at breakneck speed but because they attain their object by smarter and more deliberate methods of organisation.

Organisation—What it means.

That is the great thing—organisation. It permeates through every phase of American business life. System and method are reduced practically in many commercial houses to a science, and the results come—and come quickly.



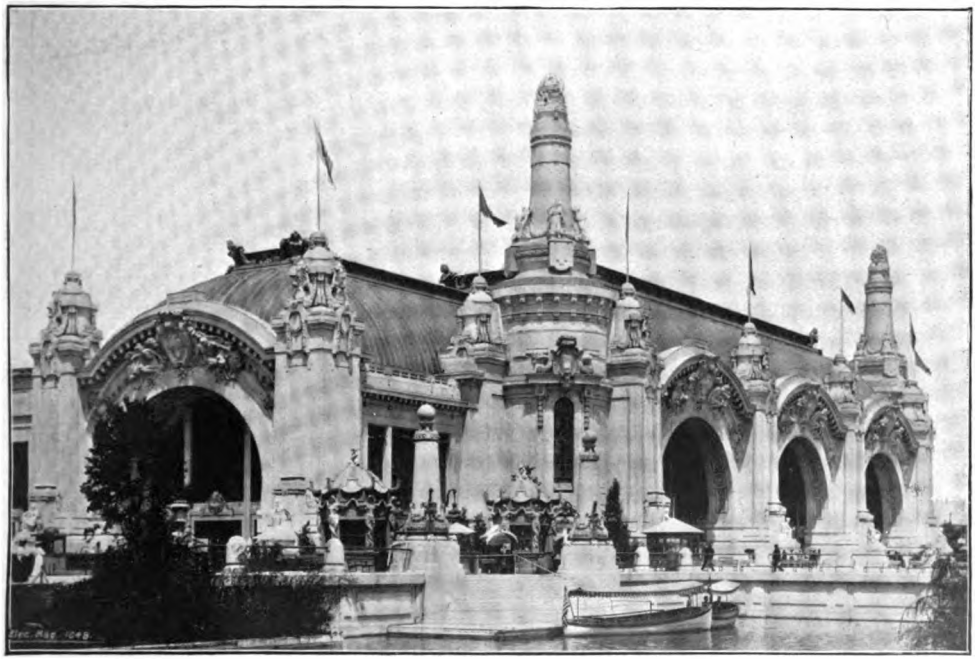
THE ITALIAN PAVILION.

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Take the advertising department, or, as they call it, the publicity department, of a big engineering firm, for instance. They have one man, with probably an assistant, and in addition a stenographer and typewriter, who devotes his entire attention to the collation of the catalogues and business announcements of other firms; and he has under his charge, carefully filed and arranged for ready reference, all the latest and best technical publications. Nothing escapes him, and by adapting the card system to the requirements of his department he is probably able to save his firm the cost of the department many times over, to say nothing of the advantage it is to have such an information bureau attached to the firm. The head of the "Publicity Department" is generally an expert, and it is his duty of course to see newspaper representatives and others and to impartially investigate the claims of everything put in front of him. The British Westinghouse Company in England have an organisation of this character, and I believe that on a minor scale one or two other of our leading firms are doing it; but the majority of British firms look upon their advertising or publicity department as something in the nature of a nuisance which has to be tolerated—and consequently neglected. Sooner or later British firms will have to awake to the fact that they must give better attention to these matters.

To the Exposition.

Later on in the afternoon I boarded a car at Olive Street and proceeded to the Exposition, where a reception was tendered between the hours of 8 and 10 P.M. by the St. Louis Committee at the New York State Building to meet the officers, delegates, and members of the International Electrical Congress.



THE TRANSPORTATION BUILDING.

So much has been written in the public press upon the Exposition that even if one had the space at disposal it would be hardly necessary to give extensive details here. It is worth placing on record, however, in this narrative the main points in connection with this mammoth undertaking. Words fail to describe the immensity of the whole thing and its countless attractions. Though in St. Louis

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PALACE OF ELECTRICITY AND LAGOON.

for a week, what with the Congress and other matters I had to attend to in the city itself, I was only able to spend about three days at the Exposition, and I can safely say that I did not see a hundredth part of it. I realised the moment that I had passed the turnstile that to attempt to "do" the Exhibition properly would be out of the question, particularly with all the functions that I, with our party, had to attend. I concluded that the best thing would be to take the Intramural railway which runs round the entire grounds. There was one fare only, viz., 10 cents, which carried a passenger to any station or around the circle. I alighted near the Electricity Building, where my interest centred. I

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PALACE OF ELECTRICITY ILLUMINATED.

confess to a feeling of disappointment at the electrical exhibits. They were not to my mind half so imposing or numerous as the occasion warranted. I am referring of course specifically to the Palace of Electricity, and not to the mammoth exhibits of the Westinghouse Company, the Allis Chalmers Company, and others in the Machinery Building. Certainly the exhibits in the Electricity Building were educational, as exemplifying the great strides that have been, and are being, made in the application of this form of energy to the uses of man, but I expected a far more representative and greater show under the circumstances. The building itself was of the Corinthian type, and was supported by a large number of majestic pillars running right round the building. It covered an area of seven acres, and possessed eight to ten spacious entrances. The architects created towers of the pedestals that carried the crowning sculpture of this splendid edifice; the beautifully executed group—silhouetted against the sky—entitled "Light and Darkness," a representation of which has appeared on the outside cover of THE ELECTRICAL MAGAZINE during the run of the Exposition. The Palace of Electricity cost something like $415,000 to build.

A Few Figures.

Here I might introduce the main facts concerning the Exhibition. It occupies 1,240 acres. What this means in magnitude of grounds is best shown by comparison. The Chicago Exposition embraced 633 acres; the Paris Exhibition of 1900 occupied 336 acres; the Pan-American Exposition at Buffalo consisted of 300 acres; the Centennial at Phila-



FESTIVAL HALL AND COLONNADE OF STATES AT NIGHT.

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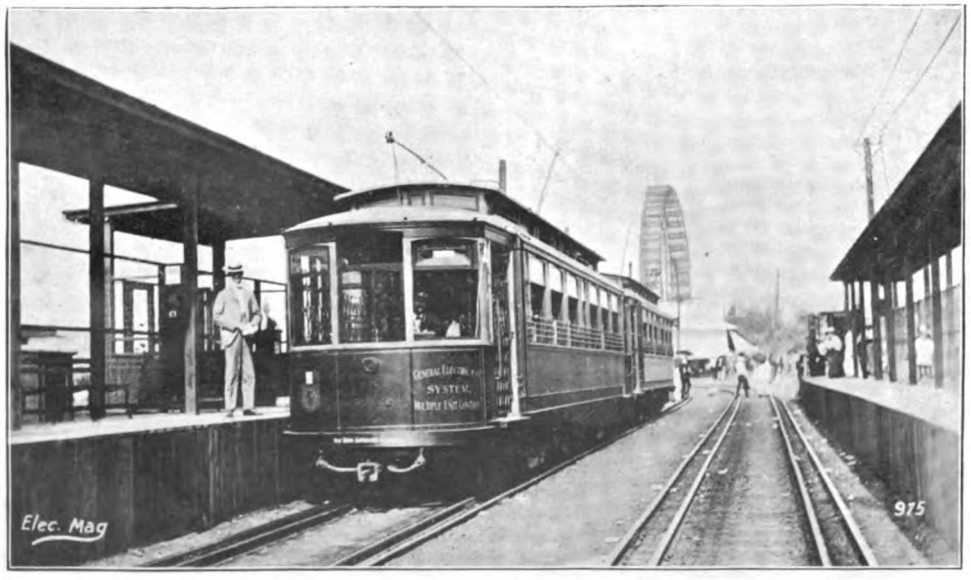


VIEW ON THE PIKE.

delphia 236 acres; and the Trans-Mississippi at Omaha 150 acres. Embraced within the limits of the World's Fair of 1904 at St. Louis, there was acreage almost equalling the aggregate of the Chicago Exposition, the Centennial, the Pan-American and the Trans-Mississippi. For this particular information and the few details to follow, I am indebted to the Press Bureau of the Exposition, the courteous general superintendent of which, Mr. Mark Bennitt, and Dr. M. M. Snell, who is responsible for most of the descriptive literature which had been circulated, afforded me every facility and information.

Beautiful Buildings.

The architecture of this universal Exposition was majestic in the great ivory white exhibit palaces and historical in the great foreign and state buildings. The palaces were the varied productions of the leading architects of the United States, designed in a chaste, harmonious scheme by these architects assembled as a Commission. The style which was adopted by the Commission is described as "a free treatment of the Renaissance." The general effect obtained



ON THE INTRAMURAL RAILWAY, AT ONE OF THE STATIONS.

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by this Commission was something to gladden the eye. Most of our members were lost in admiration of the buildings and the unique way in which they had been laid out over the grounds. The main group of buildings in the north-eastern part of the grounds consisted of twelve great structures in symmetrical arrangement somewhat in the form of a lady's fan, the avenues corresponding to the ribs. Eight of these palaces were on a level sixty feet below the others, and as the visitor entered the broad central avenue which bisects the group he looked upon a view absolutely inspiring in its grandeur. Every building could be said to be truly majestic. The richness of architectural detail has never been equalled in Exposition structures.



A Peep of the Machinery Hall.

A Charming Landscape.

The landscape had the finish of a vast garden tastefully and beautifully laid out. In the distance more than half a mile away, rose the beautiful Hall of Festivals, the central jewel of the beautiful architectural coronet adorning the broad natural amphitheatre that framed the picture. Three great cascades poured down the slope from the centre of the great Hall of Festivals to the sides. From the steps of the Festival Hall a commanding view of the principal buildings was obtained. As I gazed with admiration upon the magnificent panorama—the lagoon in front with its Venetian boats carrying delighted visitors from point to point, green slopes with banks of flowers and evergreens on either side, and the surrounding mass of beautiful buildings, the thought crossed my mind how pitiful it was that such architectural magnificence should live for such a short time. I could dilate at far greater length upon the details of the Exposition, but as I am appealing mainly to electrical readers I will not trespass further upon their time. I thought, however, that the record of our tour would be quite incomplete without some brief general references to the Exposition itself, apart altogether from the specific object of the tour.

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A Typical American Newspaper Establishment.
Offices of the "St. Louis Star."

Putting in a brief appearance at the reception at the New York State Building, I, with other members of the party, returned to the hotel somewhere near midnight.

The "Innards" of a Newspaper Office.

I had intended having a rest in my room at all events till nine or ten the next morning, but somewhere about seven o'clock the telephone-bell rang, informing me that a representative from the *St. Louis Star* was waiting for me in the hall downstairs with an invitation from the managing editor to visit him. Responding to the invitation, I was conducted to the *St. Louis Star* building, a hundred or two yards down the street in which our hotel was situated at the corner of Olive Street. The edifice in which this journal carries on its business is a typical American newspaper building. It is a veritable skyscraper. On the ground-floor are the general offices; in the basement, the machinery; on the first, second, and third, up to the sixteenth floor, are the various departments of this great daily—one of the three or four which St. Louis boasts. I was received by the managing editor, Col. Aldred, with a cordiality that was unmistakable, and we had a very pleasant half-hour together, at the conclusion of which on my communicating to him my great interest in newspaper matters, and my desire to see how an American daily was run, he very courteously offered to devote his personal time to taking me round, and initiating me into the working of the paper. This he did, and I confess to my admiration of the manner in which this establishment is run.

American Methods.

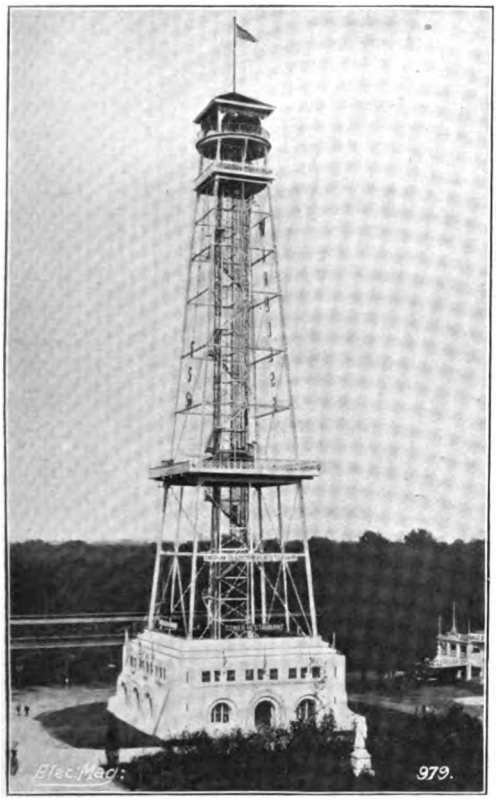
The insight I here obtained into American methods was such as to impress me with the idea that considerable improvements could be made in even the best of our British newspaper offices. I am not in favour of the style in which a great number of dailies are turned out in America, their poster headlines, scaring announcements, style of delivery and in many cases their superior imaginative faculties do not appeal to me irresistibly; but there are a great many things we can still learn from them to better our methods of working, and incidentally there are *one* or *two* things they can borrow from us with advantage. After having had the pleasure of being introduced to the editor-in-chief and other principal officers of the *St. Louis Star*, I hurried back to lunch.

The afternoon was spent again at the Ex-



A St. Louis Electrician's (?) Store.
This comprehensive depot stands on the opposite corner to the building shown above.

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De Forest Wireless Telegraph Tower.

hibition, a reception being given between 5 and 7 P.M. by the Associazione Elettrotecnica Italiana at the Italian National Pavilion in the World's Fair grounds. I regaled myself on this visit with a ride on an automobile throughout the vast grounds, in order to more expeditiously and easily find my bearings. On this evening Mr. Bion J. Arnold, as President of the American Institute, gave a dinner to the delegates.

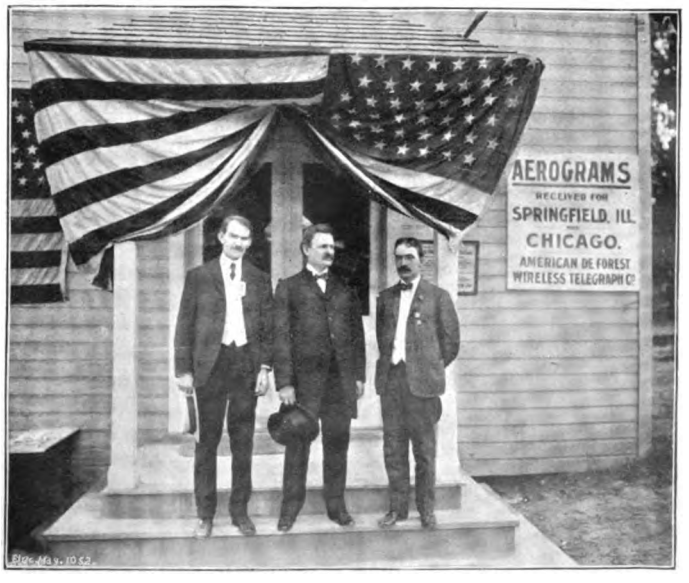
President Arnold's Speech.

President Arnold devoted a large portion of his address to a description of the system recently introduced by the New York Central Railway on its thirty-five-mile terminal tracks in New York City. The remainder consisted of a comparison of the different systems in use in America and Europe, and a strong argument for the single-phase motor for electrical railway work. President Arnold has devoted several years to its development and exploitation, besides large sums of money.

The discussion following the reading of President Arnold's address was interesting, and was participated in by a large number of the most prominent American and European scientists, who took different views on the value of the single-phase motor.

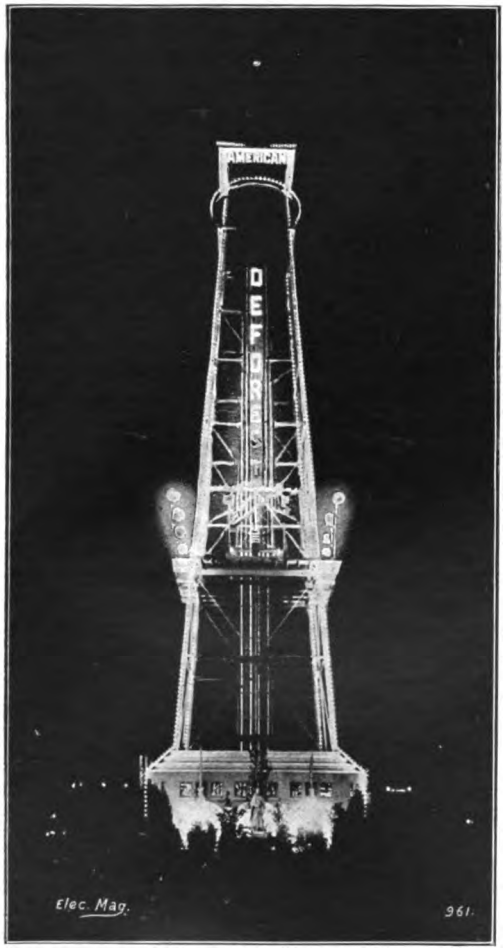
A.I.E.E. Annual Convention.

On Wednesday, September 14, the Annual Convention of the American Institute of Electrical Engineers was formally opened at Festival Hall in the grounds of the Exposition at 10 A.M. Mr. B. J. Arnold delivered the annual address, entitled "Electrical Railways and Methods and Systems of Operating." The address was prepared in a simple, untechnical style, and was very interesting to the large assemblage which gathered in Festival Hall.



Dr. De Forest, President D. R. Francis and Prof. W. E. Goldsborough at the long-distance Wireless Telegraph Station, on Art Hill.

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WIRELESS TOWER ABLAZE WITH LIGHT.

A Wireless Visit.

One of the most interesting visits I paid when at the Exposition was to the De Forest Wireless Telegraph Tower in the grounds. I with others had been invited to a demonstration when the first message would be sent to Chicago. This was done and the reply received whilst we were there. This highly successful result brought home to the minds of those present more than anything else the great advances that have been so rapidly made in wireless means of communication and the great potentialities of the De Forest system. I succeeded in taking a photograph of the sparking apparatus which was viciously spurting like a Maxim gun. The De Forest Company had a very effective exhibit in the Electricity Building, which I also paid a visit to. This is dealt with elsewhere in this issue.

Luncheon was tendered by the Engineers' Club of St. Louis at the Festival Hall in the Exposition. At 7.30 to 10 P.M. on the same day there was a reception by the exhibitors of the Palace of Electricity in honour of the members of the Congress and of the affiliated societies. This was very largely attended, practically the whole of the large party from the Jefferson being present.

Electricity Day.

This was "Electricity Day" at the Fair, and special electrical displays and attractions were in evidence. The lighting effects at night ordinarily were on an elaborate scale, but they were accentuated on this particular occasion, particularly about the Grand Basin and Festival Hall, which was a magnificent sight. Decorative lamps were also slung in trees about the Palace of Electricity.



WIRELESS TELEPHONE STATION.
The arc light throws a beam along which the message is sent.

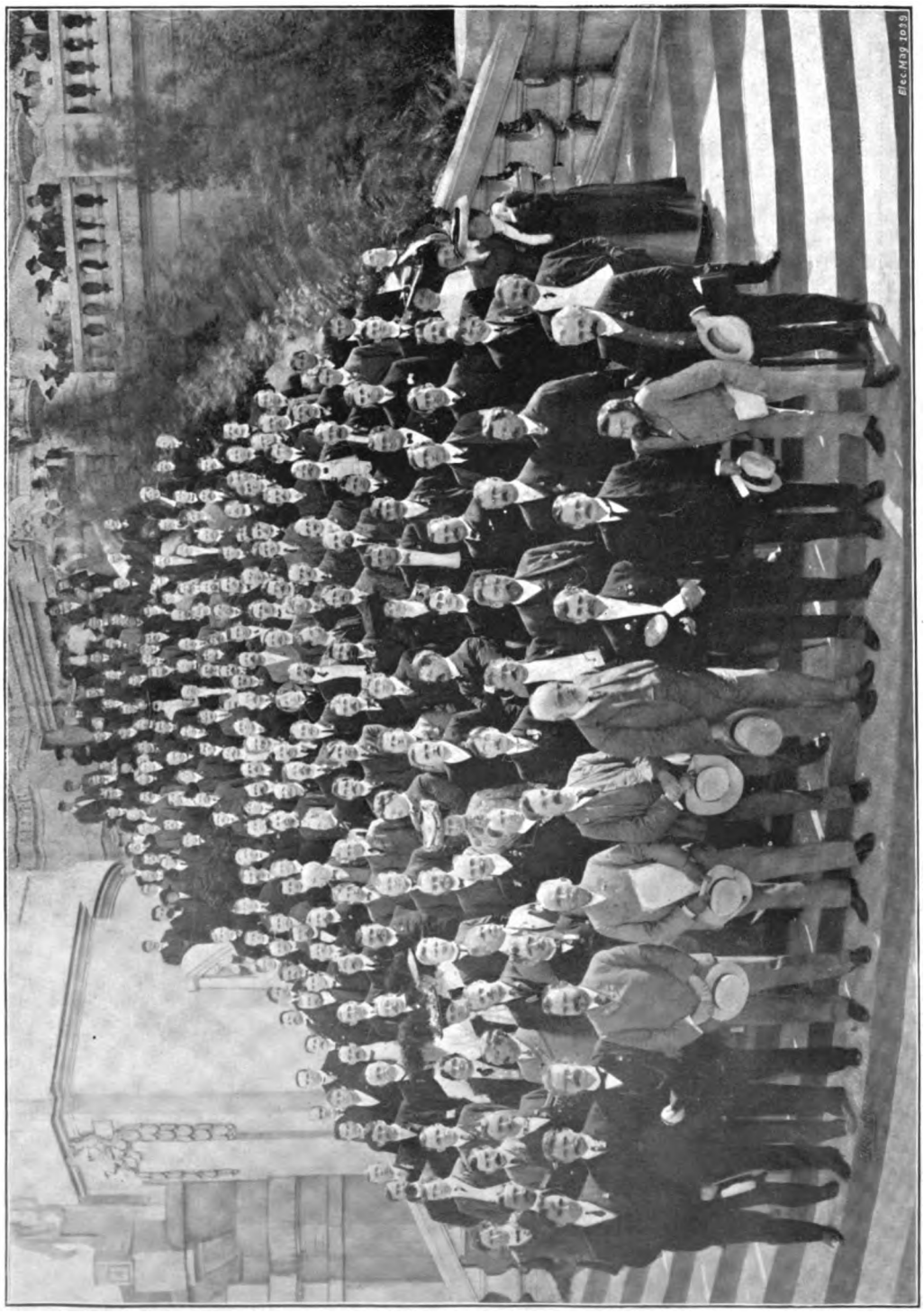
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MACHINERY HALL ON "ST. LOUIS DAY." A FLOOD OF LIGHT.

On the north side of the building along the lagoon was a high-tension line connected to a 100-kw. transformer with a secondary potential of 50,000 volts. This was in operation, showing the spectacular effects of high-potential discharges. In the Grand Basin adjoining the electrical building were anchored six floats with special electrical features. One commemorated the twenty-fifth anniversary of the commercial development of the incandescent lamp; one showed a space-telegraph station; another an X-ray phenomenon. The Palace of Electricity and the bridges across the lagoon were decorated with flags and special banners. During the evening a imposing procession of motor-cars and horse-vehicles paraded

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Visiting Electricians at St. Louis.
An International Group taken on the steps of the Festival Hall.

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the grounds with emblematic signs of the various branches of electrical work. Instead of closing down at the usual time, the exhibitors of the Electrical Palace not only had their stands brilliantly and specially illuminated, but the exhibits were in operation up till 10 P.M. The reception was held on the south side balconies, from which a superb view of the illuminations could be obtained, and I with other members took the opportunity of securing some night pictures.

Thursday, September 15, was St. Louis Day, and there was no set programme for the visiting engineers. In appreciation of the spirit that prevailed in the city for making this day the overshadowing event of the whole World's Fair, the International Electrical Congress, after a brief session, adjourned to attend the celebration in a body. The various sections met in short session at 9 A.M., but no work was undertaken, and the reading of all papers was adjourned until the next day.

At the Exposition a marvellous sight presented itself. From a very early hour tens of thousands of people had been pouring in through the turnstiles. The two routes from the city contained one endless chain of trolley-cars packed to excess, there was not even standing-room in any car till about noon. The sight at the Exhibition was worth a visit; but owing to the gigantic crowds, despite the vast grounds, moving about was quite uncomfortable, and after taking a few photographs I was glad to get away. Even at a comparatively early hour people realised that there would be a great crush on the return journey, and at five o'clock when I left it was extremely difficult to get a seat in a car. If no one else was satisfied with the crowd, the amusement and refreshment caterers on the Pike undoubtedly were, judging from the attendances, and the management was doubtless gratified at the huge demonstration. St. Louis meant to do the thing well on this day, and did it!

A Dignified Function.

On Friday, September 16, a reception was held from 4 to 6 P.M. by the Commissioner-General for Great Britain and Mrs. Watson, at the British National Pavilion, which was a very enjoyable function, simple, unostentatious and dignified. One of the American delegates (I won't mention any names) confessed to me, at the same time hoping that he was not drawing invidious comparisons, that this reception did great credit to the manners and customs of our country, and was something in the nature of a welcome relief from the crush that had attended one or two of the others. At 7.30 P.M. a banquet in honour of the British, Italian, and other members of the Congress from abroad was held at the German National Pavilion, which was very largely attended. A number of speeches were made, expressing the most friendly sentiments on both sides, and Mr. D. R. Francis, the President of the Exposition, had some very appropriate words to say. The feeling of *camaraderie* which had characterised all the social gatherings on the tour was intensified at this meeting, and the party broke up in excellent form.

On Saturday, September 17, President Gray entertained a large luncheon-party at the New York State House. This day was given up by most of the party to a final visit to the Exposition and to a last run round the city for the purchase of souvenirs and one thing and another.

Weather Surprises.

The weather during our entire stay in St. Louis had been on the whole of a remarkable character for the time of year. The accounts that had been given to us of the climate of St. Louis in September led us to believe that we should have something fearful to go through with the heat. We were agreeably surprised, however, to find that it was delightfully cool comparatively, that is, with the exception of Wednesday (when, after a somewhat sultry afternoon, an electric storm suddenly burst over the Exhibition, drenching most of us to the skin who had light clothes on and naturally no umbrellas) and Saturday, the day of our departure, when the atmosphere became very heavy and humid. The weather during the other days was simply superb, like the best days of an English summer. The closing meeting of the International Congress was held on this day, and at 7.30 P.M. carriages were in waiting outside the Jefferson to convey us to the Pennsylvania Line Station.

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Before leaving St. Louis I cannot speak too highly of all the courtesies that were extended to us there. Right up to the very last moment these were in evidence. The members of the local committee, together with Professor Elihu Thomson and other gentlemen, escorted us to our carriages, and with hearty handshakes and many cordial greetings we departed to the station. The baggage had gone on, and promptly at 8 P.M. our special left St. Louis for Pittsburg. Members of the party were not long in turning into their berths after what, with the state of the weather, proved out to be a very fatiguing day. I ought not to omit to mention that the ladies had been specially catered for during our stay.

PITTSBURG.

WE arrived at Pittsburg about 4 P.M. on the afternoon of Sunday, September 18, after having breakfast and luncheon served *en route*. Mr. Charles F. Scott, the chairman of the local reception committee, together with three or four of his colleagues on the committee, had travelled with us from St. Louis, and extended to us a hearty welcome, presenting us with a neat little pamphlet containing the programme of our trips of inspection whilst in Pittsburg. Mr. Scott, who is now consulting engineer to the Westinghouse Electric and Manufacturing Company, is one of the leading lights of American electrical thought and work. After studying the physical sciences under Drs. Carl Mees and T. C. Mendenhall in 1885, he took seriously to electrical work in 1887, and was employed on some pioneer alternate-current work at Philadelphia. Entering the service of the Westinghouse Company in 1888 he ultimately became Nikola Tesla's assistant in the latter's historic work on induction motors. He is chiefly famous for a three-phase two-phase transforming method developed by him in 1894, and in addition has contributed many valuable papers on electrical transmission problems. The visits arranged for us were as follows: To the Westinghouse Electric and Manufacturing Company's works; the Westinghouse Machine Company; the Union Switch and Signal Company; the Westinghouse Air Brake Company; the Nernst Lamp Company; the Carnegie Steel Works at Bessemer and Homestead; and the R. D. Nuttall Company. There were six trips in all, and no one member could take them entire, so had to make selections. Special cars were provided to reach the various points, through the courtesy of the Pittsburg Railways Company.



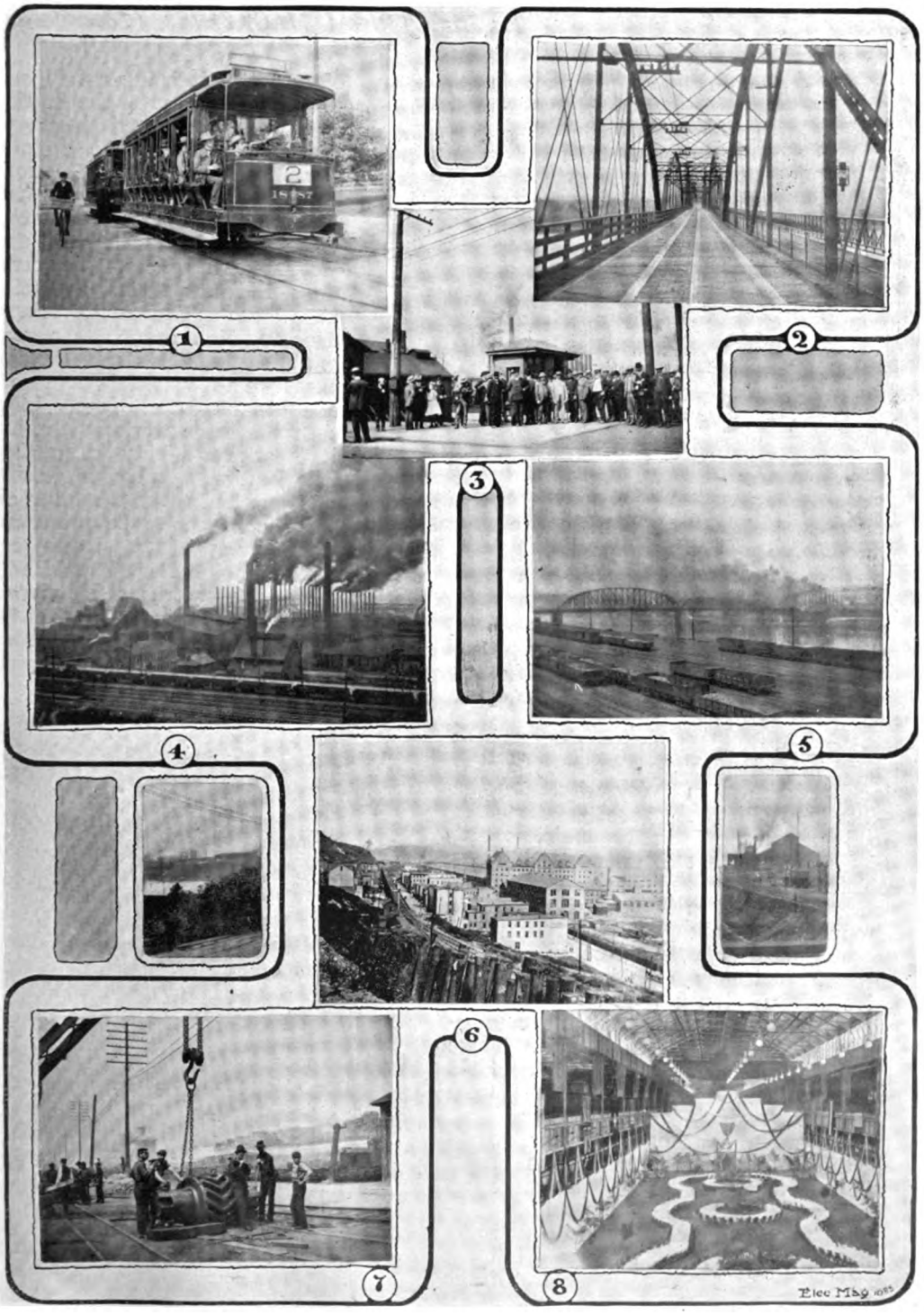
CHARLES F. SCOTT



CARNEGIE INSTITUTE, PITTSBURG.

On arriving at Pittsburg Station, four-in-hands and other conveyances were in waiting for us, and we were quickly transported to the Hotel Schenley. I was greatly surprised at my first view of Pittsburg. I had heard the familiar expression in connection with this place, and was not prepared to see a living green thing. I was astounded to see the elegant broad streets and the splendid residences, surrounded by luxuriant foliage on every hand. I remarked upon

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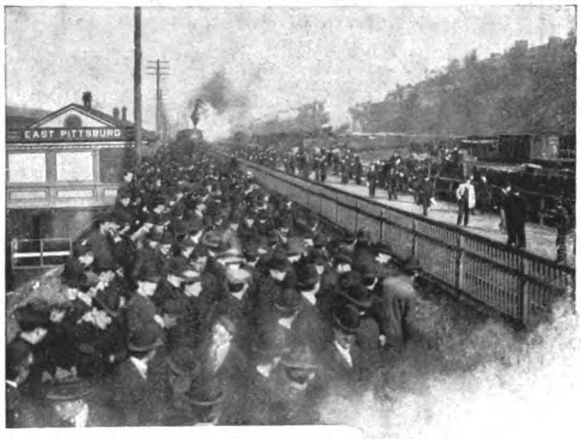


PITTSBURG.

1. Start for the Steel Works. *2. Suspension Bridge connecting East and West Pittsburg.*
3. Outside the "Homestead Works." *4. & 5. Views at East Pittsburg.* *6. The Westinghouse Works.*
7. Hooking a Big Casting. *8. Banquet Tables, Main Shop, Westinghouse Works.*

Photos by Messrs. Pyne, Cormack, Barnes, Atchison, and Feilden.

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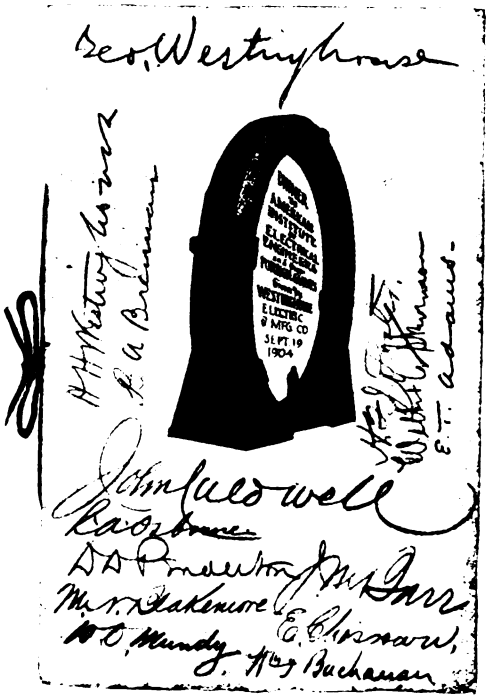
EMPLOYEES LEAVING WESTINGHOUSE WORKS.

the place in wonderment to Mr. Scott, and he smiled. It is only in the immediate vicinity of the steel works that Pittsburg can lay claim to rival Sheffield in its popular conception. Even then, when I gazed upon it from various points of vantage during the course of the drive later in the day, I would give the palm for smoke and dirt by a long way to the cutlery town. I think also that Sheffield is far more impressive as a busy manufacturing centre in every way. On the other hand, Pittsburg has a greater claim to impressiveness in the majestic size of its mammoth steel works. Whereas Sheffield appears a conglomeration of workshops, and one would imagine if dropped suddenly into the city that vegetation was a thing never seen or heard of, Pittsburg can be viewed as a hive of industry nestled on the bosom of a great track of beautiful country which meets the eye at every turn. There is beautiful country around Sheffield of course, but it is not so blended from the view standpoint as at Pittsburg.

Within an hour or two after arrival at the Hotel Schenley dinner was served. We retired fairly early, and were up betimes. The weather was still beautifully fine, as it had been practically throughout the tour. At 9.30 I left the hotel for the Homestead works of the Carnegie Company.

An American Sheffield.

A visit to this great place is an object-lesson. At the gates we were deprived of cameras, it being a rule not to allow them into the works, and were conducted in small parties throughout the gigantic workshops, witnessing the rolling of mammoth steel plates and the various processes of steel manufacture by all the latest and most modern devices. The operations did not materially differ from those at Cammells, Vickers, Sons and Maxim, and other great establishments in Great Britain, except in a few special particulars adapted to circumstances. I had seen the same work before, but it is always highly interesting. The heat was, of course, terrific, and one had to be careful where one trod if boots were to be preserved. Leaving the Homestead shops, cars took us to the Westinghouse Electric and Manufacturing Company's works, a fine view of which was obtained from the brow of the hill. I was unfortunately taken ill immediately after my arrival there, largely



MENU OF BANQUET AT WESTINGHOUSE WORKS, WITH AUTOGRAPHS OF GEO. WESTINGHOUSE AND HIS ENGINEERS, OBTAINED AT THE TIME.

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owing, no doubt, to the terrific "hustle" I had gone through and the bolting of food to get conscientiously through the programme. I shall not readily forget the kindly ministrations of Mr. Scott, who sent for a doctor and gave me every attention. I was greatly mortified at having to lay up for four or five hours whilst our party traversed the great works, but I was sufficiently recovered by about six o'clock to have a run through. A simple but curious little episode occurred whilst I was being escorted along one of the big shops. I had tried whilst on my tour through the States to secure one of the beautiful butterflies that I had seen at various stages on the journey, but I had no apparatus with me with which to obtain one without harm to its appearance. Whilst watching the machinery in operation with my guide in the main Westinghouse shop, one of these beautiful insects was electrocuted before my eyes and fell at my feet. I have it now among my collection as one of my most prized souvenirs.

The Westinghouse Banquet.

At 6 to 7 P.M. all the visiting parties congregated at the works of the Westinghouse Electric and Manufacturing Company to an informal reception and banquet. Mr. George Westinghouse presided, supported by all the principal members of the Westinghouse staff in America. The huge bay of the principal machine-shop had been turned into a gigantic dining-room. The tables had been arranged in a most unique manner in the centre, presenting a serpentine aspect. The great shop was lighted brilliantly by the Bremer arc lamp, and the whole place was festooned with the national flags of the delegates of the visiting nations. Owing to my condition (which I afterwards ascertained was that of some other members of the party) I am afraid I did very meagre justice to the excellent fare that was put before us; but I nevertheless enjoyed the novelty of the proceedings, and I was fortunate in having seated near me a number of the chief officials of the Westinghouse Company, with whom I made very good friends. A nicer lot of fellows I never met, and I shall always look back upon that visit with the greatest gratification and pleasure, apart from my indisposition. Mr. George Westinghouse welcomed us in an entertaining little speech, and thanks were briefly returned by Presidents Gray, Arnold, and Ascoli. On the party breaking up, Mr. George Westinghouse, with his brother and a number of other well-known officers of the concern, personally escorted us to the train and gave us a hearty send-off. We left for the capital at 9.30 P.M.



WASHINGTON.

WE arrived at Washington at 9.30 the following morning (Tuesday, September 20), being driven in horse-conveyances to the new Willard Hotel, where breakfast was served. Shortly after, we boarded electric-cars—conduit; no trolley-cars being allowed to appear in the streets of Washington—*en route* for the United States Bureau of Standards, which was to be formally dedicated on our visit. The route lay through part of the beautiful outskirts of Washington, giving one a good idea of the development of the capital for residential purposes. The homesteads that were being built on the way nestled among splendid sylvan scenery, and were the admiration of all of us. In half an hour or so we alighted, and taking a short walk through a beautifully wooded spot came upon the buildings of the Bureau, the latest addition to which was in course of erection and about half-way completed. After an address by the courteous president, Dr. S. W. Stratton, the building was formally dedicated, and an interesting visit terminated.

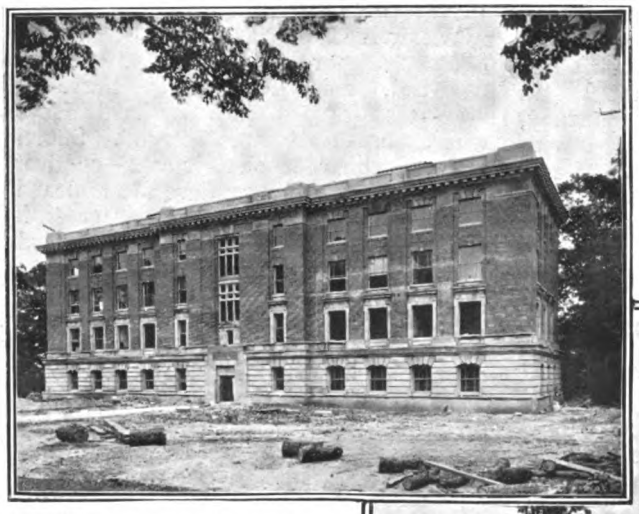
We left the Bureau of Standards between 10.30 and 11 A.M., and were carried back past the White House, the new Willard Hotel, and down the magnificent avenue which forms the main thoroughfare of Washington, to the Capitol, where special guides were in attendance to take us over this world-famed building, all the various matters of interest being lucidly and interestingly explained by the officials. Leaving the Capitol, we proceeded on foot to the magnificent Library of Congress, but a short distance away, and after a brief inspection of the library building we repaired to the *café* on the top floor, where lunch was served. A superb view of the city

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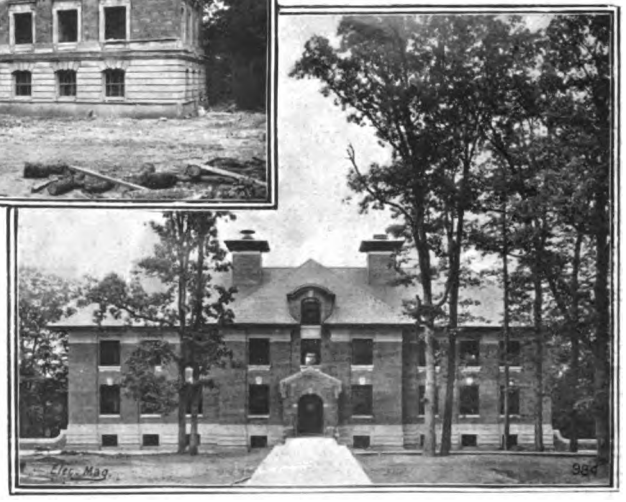
was obtained from the gallery of this building, and a number of photographs were taken of the Capitol and the surroundings.

Objects of Interest.

After luncheon at 2 P.M., the party was divided into groups, and paid visits to the following points of interest: Central Stations; Telephone Centrals; Navy Yard, including the Experimental Model Basin, the Gun Shops, and the Wireless Telegraph Station; the Government Printing Office; Mount Vernon; the Treasury, White House, State, War, and Navy Departments and Corcoran Art Gallery; Washington Monument, Bureau of Engraving and Printing, Smithsonian Institution and National Museum. I had only time to visit the War and Navy Departments, the Corcoran Art Gallery, and Washington Monument, taking a drive through the Park with Mr. Geipel, who, unfortunately, had been very unwell during part of the tour. Returning to the hotel at 6.30, supper was served.



NEW BUILDINGS OF THE BUREAU OF STANDARDS, WASHINGTON.



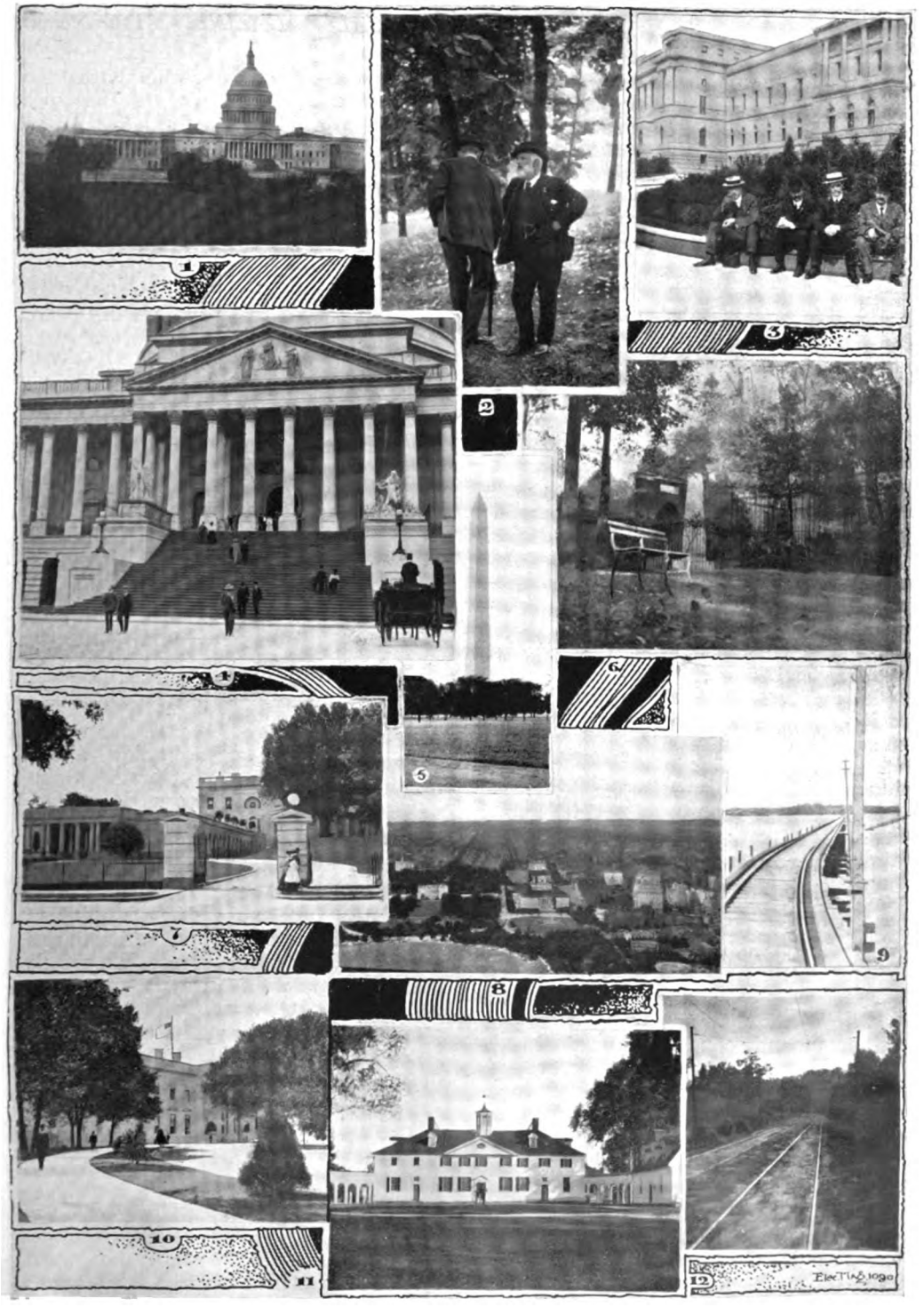
The thanks of our party are due to the care which the local reception committee at Washington exercised in ministering to our enjoyment. Mr. George H. Harries, Chairman, and Mr. Philander Betts, the Secretary, together with their able assistants, extended to us such courtesies on this short visit as will remain in the minds of all.

After supper we were conveyed by coaches to the Pennsylvania Railroad station, leaving there on our Special at 8 P.M. for Philadelphia. Passing through Baltimore at 9 P.M., Wilmington at 10.20, and Chester at 10.40, we arrived at Broad Street, Philadelphia, within a few minutes past eleven, and walked to the new Bellevue-Stratford Hotel, which had been made our headquarters.

PHILADELPHIA.

WE had been escorted from Washington to this city by the Chairman of the Philadelphia reception committee, Mr. J. B. McCall, and his associates, Messrs. W. H. Johnson and H. F. Sanville. The genial chairman is the President of the Philadelphia Electric Company, a position he has obtained after a most strenuous career. He had previously been president of the Pennsylvania Manufacturing, Light, and Power Company, his experience prior to that date being obtained with a number of Pennsylvania lighting companies. He has been president of the Association of Edison Illuminating Companies for the past ten years.

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WASHINGTON.

1. The Capitol. *2. Mr. R. Kaye Gray and Dr. Glazebrook at Bureau of Standards.*
3. Mr. Hayashi, Mr. Marr, Mr. Tree, and an "American Cousin" outside Congress Library Building.
4. Leaving the Congress Library. *5. The Washington Monument.* *6. Washington's Last Resting Place.*
7. Outside the White House. *8. View of Washington from Top of Monument.*
9. Bridge for Trolley Cars over Potomac to Mount Vernon. *10. Front Entrance, White House.*
11. Washington's Old Home. *12. On the Road to Mount Vernon.*

Photos by Messrs. Hayashi, Marr, Cormack, and Feilden.

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Tallest Hotel in the World.

When we entered the Bellevue-Stratford, America's tallest and latest hotel, an extraordinary sight greeted us. It was a mass of flowers and foliage, and one would have thought that a great wedding-party had assembled. As a matter of fact, it was the opening of the hotel, and the management had performed herculean efforts to get it ready in time for our visit. I was told that the day before, the carpets were not down, yet there was scarcely an indication that the place had not been in full working order for a week or two. There was, naturally, a little confusion in allocating bedrooms, as everything could not work quite smoothly with such a rush; but within half an hour or so everybody seemed to be located, and before midnight the party had retired to rest. The bedrooms were most sumptuous and the accommodation perfect, in fact the hotel is a luxurious palace.

On rising the next morning I obtained a splendid view of the city from my bedroom window. The sun was shining brilliantly, but it was a colder morning than we had yet experienced, the wind blowing strongly and keenly. Breakfast was served at 8 A.M., and coaches left the hotel at nine o'clock for a visit to the following points of interest: the main generating-station of the Philadelphia Electric Company; the Baldwin Locomotive Works; the United States Mint; and the power-house of the Philadelphia Rapid Transit Company.

At the latter we inspected an installation of four 1,500-kw. and two 800-kw. 550-volt Westinghouse railway generators with compound condensing engines. A new turbine station was in course of erection, but had not progressed to a point of completion sufficient for inspection by our party.

Interesting Visits.

Retaking coaches, we were driven round the grounds of the University of Pennsylvania, the third oldest university in the United States. It covers fifty-five acres, on which stand thirty-three different buildings. It furnishes instruction to three thousand students. Crossing Schuylkill River on the South Street bridge, we observed to the right on the east bank the main generating-station of the Philadelphia Electric Company, the very affable president of which, Mr. J. B. McCall, I had seated on my right on the coach. Mr. McCall explained to me that this generating-station was designed for an ultimate capacity of 200,000 h.p. Engine-driven units aggregating 10,000 kw. capacity had already been placed. He intimated that the installation would probably be completed with vertical turbo-alternators. After an inspection of the plant, we drove east to Broad Street, and then north to the Baldwin Locomotive Works These are the largest locomotive works in the world. Some idea of their immensity will be obtained when I say that their annual capacity is about two thousand locomotives, and that the works employ about fifteen thousand men. Approximately 40 per cent. of all the locomotives manufactured annually in the United States are turned out by this company. To say that we had an opportunity of inspecting these works would be to suggest something that was ridiculous. We simply took a smart walk through the huge shops, and there was barely time to examine anything. When I say we took a walk through, I am told that we went through probably about one-third of this gigantic place, where locomotives were being made by the hundreds for the United States, and for export. There seems to be a pretty big electrical equipment in the works, and they are up-to-date in every particular.

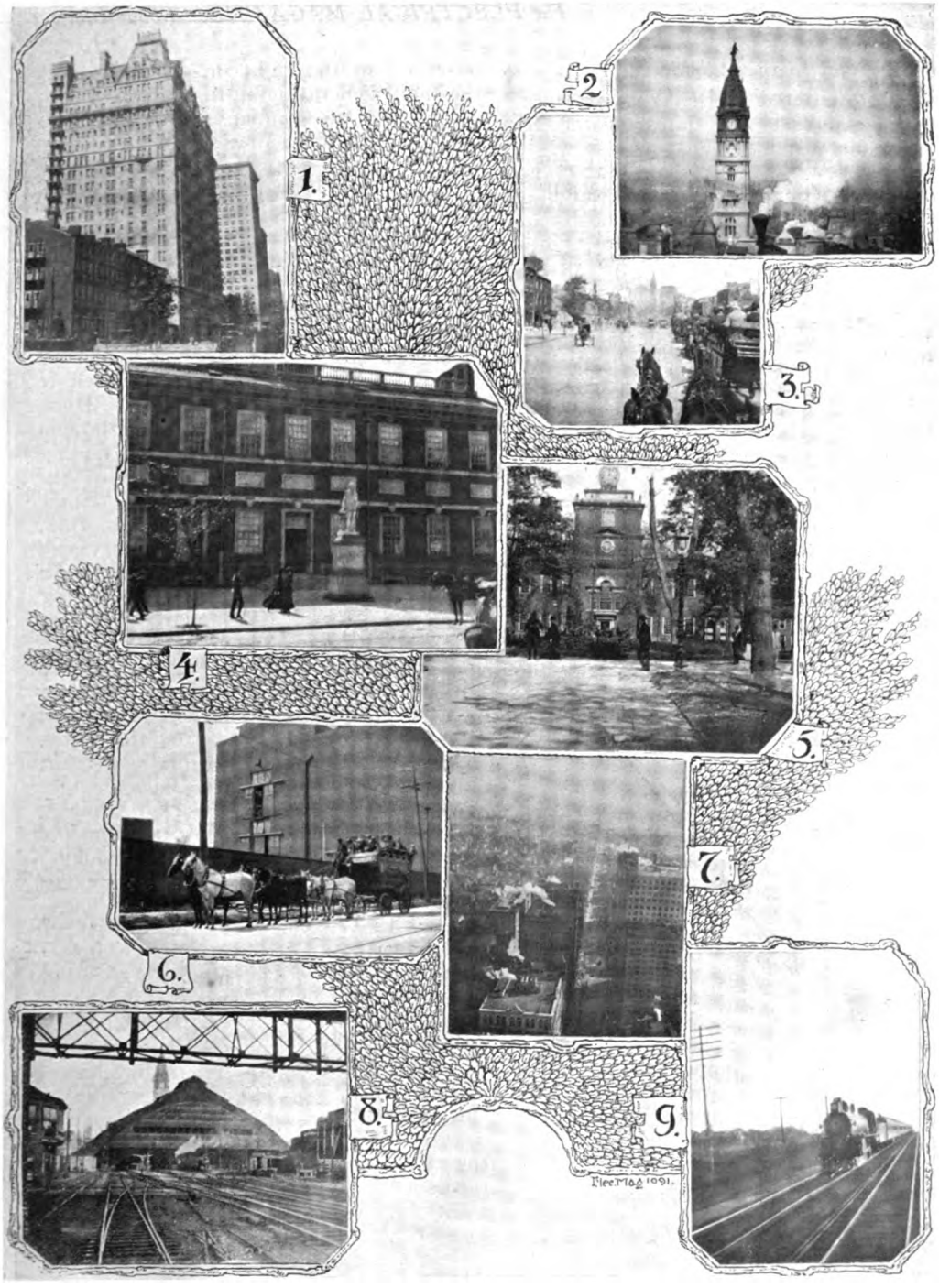


J. B. McCALL.

At the Mint.

We left the Baldwin Works at Sixteenth and Spring Garden Streets for the United States Mint. This is said to be the largest and most completely equipped mint-building in the world. The machinery

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PHILADELPHIA.

1. *The Bellevue-Stratford.*
2. *Tower of the City Hall (taken from top of North American Building).*
3. *Drive back to the Hotel.*
4. *Independence Hall from street.*
5. *Back of Independence Hall.*
6. *Visiting Power Houses.*
7. *View of Philadelphia from Bedroom of Bellevue-Stratford.*
8. *Leaving Philadelphia.*
9. *On the Road to New York.*

Photos by Messrs. Bate:, Longbottom, Barnes, Marr, Morse, and Feilden.

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is run by direct-connected electric motors, receiving current from a central plant of 900 h.p. The cost of the building and grounds was $2,000,000, including $400,000 for mechanical equipment. We had a brief but interesting inspection of the main building, during which we witnessed, through a screen of plate-glass on a balcony, the coining of gold, silver, and copper pieces. We were shown round by Abram Setley, an old veteran of the Civil War, who sold us souvenirs at parting. in the shape of brass-gilt coins about the size of half a farthing, explaining that they were stamped on the first press used by the Mint.

Coaches were then retaken east to Spring Garden Street and on to Broad Street to the Bellevue-Stratford Hotel, passing the City Hall *en route*. The Philadelphia City Hall is the largest and most costly municipal building in America, erected at a cost of $23,000,000. It contains 634 rooms, including the mayor's offices, law courts, &c. The gigantic tower, which is capped by the immense statue of Penn, is 547 ft. in height.

The hotel was reached at 1.15, and at 1.30 we sat down to luncheon given in our honour by the local reception committee. I do not wish to draw any comparisons when I say that this was about one of the most enjoyable of the festive gatherings we had on the tour. The pity of it was that we had not time to see more of our hosts and the various friends who made themselves known to us. I was gratified to find that my table was composed entirely of newspaper men, among them some of the most prominent journalists in Philadelphia. I shall look forward with pleasure to renewing the acquaintance of the four gentlemen I had the gratification of meeting on this occasion. They were Mr. Harrington Fitzgerald, Managing Editor of the *Philadelphia Daily Item*; Mr. Stephen Pfeil, of the *Philadelphia Record*; Mr. Albert E. Turner, Financial Editor of the *North American*; and Mr. W. A. Connor, Philadelphia agent for the Associated Press.

I must not forget to tender here my thanks to Mr. Harold Calvert, of the Philadelphia Electric Company, who acted as my guide, and to Mr. W. C. Eglin, the courteous electrical engineer of the Philadelphia Light and Power Company.

Bustle and Hustle.

The worst part of the visit to Philadelphia was the terrific rush that had to be made almost before luncheon was finished, and there was scarcely any time to listen to the words of welcome which were extended to us on this occasion. It was after three o'clock before we rose from the tables, and our train was timed to leave the Broad Street Station of the Pennsylvania Railroad at 3.30 P.M. promptly. I had to make a dash for the inquiry counter to give final directions as to my baggage, and what with the leave-taking and one thing and another I only caught the train by a bare half-minute. Within half an hour from starting I was made unpleasantly aware of the fact that my baggage had not come aboard. Incidentally, I did not recover it until two days afterwards, when after numerous letters and telegrams it finally arrived at the Waldorf, New York. Mr. Long, of Norwich, and another member of the party were unfortunately in the same plight, the former gentleman only recovering his within a few hours of sailing for England on the *Arabic*.

I would like to mention that the ladies had been specially catered for at Philadelphia, as they had been in other places. They were taken to several points of interest in the city and for a very enjoyable drive to the valley of the Wissahickon Creek.

We arrived at the New York railway terminus about 5.30 P.M., after a somewhat exciting but most enjoyable day.



NEW YORK.

AT 5.30 the same evening we reached New York, and on alighting from our luxurious train, which I was almost sorry to part with, I realised that this concluded the Special Circular Tour of the American Institute of Electrical Engineers.

So great had been the rush that I felt, figuratively speaking, I had only been away from the metropolis of the United States for about ten minutes. We had been flying through space day and night, and had done and seen so many things that I thought it would be a marvel if I remembered anything when I returned to

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England. I had taken very few notes, but my memory serves me in most cases; and with this, in conjunction with the literature supplied us, which was of a high order, I have been able to piece together this story.

An Acknowledgment.

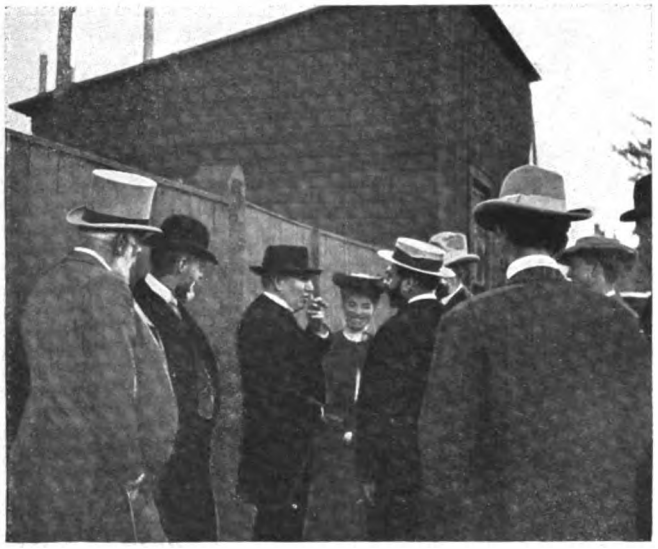
Referring to this literature, I have no words of commendation sufficient to express my pleasure at receiving the very elegant handbooks supplied by the various local committees of the towns we visited. These books number ten in all, including one from the Edison Company. They were all of the same size and bound in the same identical style in green with gold letters and conspicuous labels on the back. The whole set forms a very complete little reference library. I greatly prize these books, and I hope that when one of these days we have the honour of entertaining our American cousins in return for all the courtesies they have extended to us, our Institution will see that something of a similar kind is provided for their benefit.

It was thought that our visits had now come to an end with the execution of the official programme; but Mr. Thomas Alva Edison had extended to us a very cordial invitation to visit his laboratories at West Orange, New Jersey, on Thursday, September 22. Thither the majority of the party repaired on that day, and we were very hospitably entertained by the "wizard" of America, assisted by Mrs. John R. Schemerhorn, Mrs. Walter S. Mallory, and his niece, Miss Edith Edison. The afternoon spent at Mr. Edison's workshops was an intellectual treat of the first order. Our party consisted of about one hundred, and the great inventor greeted us with a pleased look and took much pride in explaining his inventions, discoveries, and the work of his laboratory. I was fortunate, with other members of the party, in being personally conducted round by Mr. Edison, who thought no item too small to explain and no question apparently too trivial to answer. He showed us everything, from the making of the wax cylinders for his phonographs to



A Representative Group at Mr. Edison's Laboratory.

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GROUPED ROUND THE GREAT INVENTOR.

the piecing together with lightning rapidity of his packing-cases. The sage took as much interest and delight in an exhibition of the cinematograph in his little theatre as any man among the party. Mr. Edison's personality is a remarkable one. One feels when talking to him that one is in the presence of a truly marvellous man ; but he is so simple, unostentatious, quiet, and withal so friendly in his demeanour that I felt after half an hour's chat that I had known him all my life. Mr. Edison provided refreshments for us in the library of his laboratory, and courteously gave me his autograph, whilst he congratulated me upon THE ELECTRICAL MAGAZINE.

A special train had brought us on the Erie Railroad from Jersey City, and at five o'clock we were informed that it was time to depart from Mr. Edison's enthralling workshops. Just before departure, the party was photographed by the *Newark Daily Advertiser*, and I reproduce a copy of the photograph on page 59. The faces on either side and around Mr. Edison will be recognised by most of my readers. Mr. Edison was good enough to pose for me on one or two occasions during the visit, and I have reproduced two characteristic pictures. The last one, in which Mr. Edison is standing with his back to the fence outside his workshop with a cigar poised between his fingers, is of the greatest interest to me and recalls a rather amusing incident.

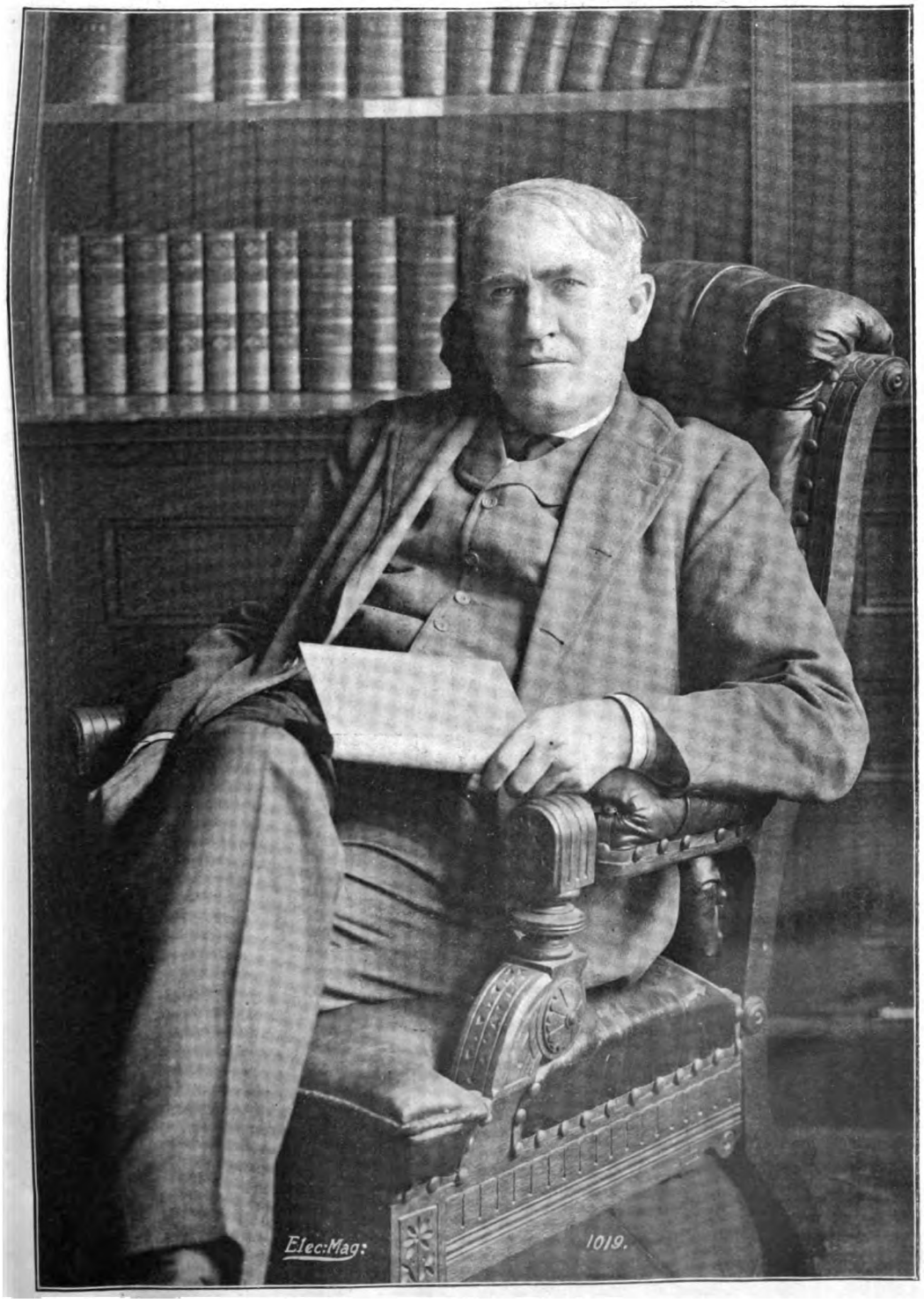
A Final Picture.

I was the last to shake hands with the great inventor, and I asked him if he would stand for a final picture. He was watching our party boarding the train with rather a sad look upon his face, which, when I stepped back with the camera, opened out into his sunny smile. "You will miss your train," he said to me in an undertone, repeating it twice as I was focusing and snapping. He laughed outright at last when he saw the dash I had to make to scramble into the last carriage as it was moving off, and waved me a final farewell. A short time after my return to England my genial host sent me a very characteristic photograph of himself, of which I have had a full-page reproduction made for this issue, and which I am sure



FAREWELL!

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Thomas Alva Edison.

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J. W. Lieb, Junr.
(President of the A.I.E.E.)

will be much appreciated by Mr. Edison's countless admirers, as it portrays the great inventor to the life.

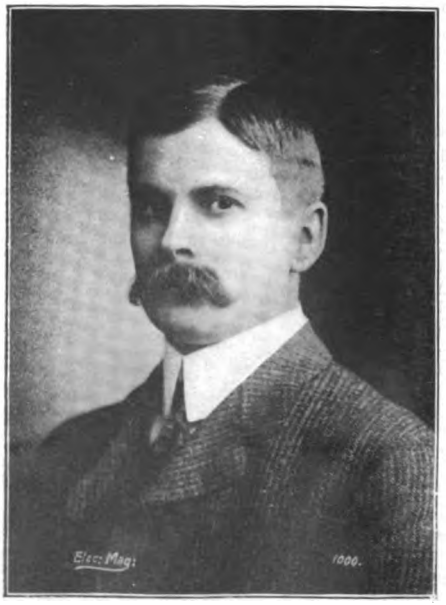
FAREWELL SUPPER.

On the evening of September 22 a farewell supper was given by the British tour party in the Myrtle Room of the Waldorf-Astoria, to the members of reception committees and other American gentlemen. A very pleasant evening was spent, and the British engineers had the pleasure of the company of a number of those who had extended so many courtesies to them while on the tour, some of whom had accompanied the party on the round trip. The supper was delightfully free from formalities, and our party had the satisfaction of being able to testify in an unmistakable manner to the hospitality and generosity of our hosts on the trip. Mr. Gray, who was Chairman of the supper, in a few appropriate words, expressed to Mr. Lieb our very great indebtedness to him for all the consideration and kindness he had shown us, and on behalf of the British party presented to Mr. R. W. Pope, Secretary of the American Institute, a solid silver casket, beautifully chased and bearing the inscription: "R. W. Pope, from his friends of the British Institution of Electrical Engineers, New York, September 1904." Colonel Crompton thanked, on behalf of the party, those manufacturers and Supply Companies who had so generously thrown their works open to our inspection. We had been allowed to see everything we wished to see, Colonel Crompton said, and we should never forget the people we had met. He hoped we should have an opportunity of reciprocating.

President Gray next rose to thank, in the name of the visitors, the local committees who had done so much for us, and said we should all carry away with us some lively recollections of their kindness.

Mr. Edgar, Chairman of the Boston reception committee, said it had been his personal good fortune to be the first to welcome the English visitors to America. So far as the performance of his duties had allowed him, he had done all he could to make the visit a successful one. He wished us God speed, and a safe return.

Mr. T. Commerford Martin, Chairman of the New York reception committee, followed Mr. Edgar with a very diverting



Bion J. Arnold,
Past President of the A.I.E.E.

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GILBERT SHOWING HIS EXPERIMENTS ON ELECTRICITY TO QUEEN ELIZABETH AND HER COURT. (*See* page 64.)

speech. In the course of his remarks he said that it was early days in England with some of us yet, and intimated that there were very great possibilities in front, but Japan had to be reckoned with undoubtedly. At the dinner given by the American Institute to their British *confrères* at New York at the starting of the tour, the key of admission, Franklin's key, had, Mr. Martin said, been the "open sesame" to at least ten cities of America, one of which still flew the good old Union Jack. He wanted that key to remind us that we were always welcome. He was sorry for the infrequency of the visits of the English electrical engineers to the United States, and it was the wish of all that we should come again and again. He hoped that when we went home to England we should feel that we had been amongst friends and amongst kindred. One of the most extraordinary things in connection with the international situation was that America knew more about England than England knew about the United States. One hundred thousand visitors go over to Great Britain per annum, whilst about five thousand Englishmen come over to America from the United Kingdom. He was glad that we had been able to inspect their factories and visit their electric light and power-plants. We should doubtless go home and make reports. Colonel Crompton had referred to the fact that the visits to the various works had been of use, and he hoped we would take back all the information possible to keep or to copy. He trusted his remarks would be taken in the spirit in which they were intended. Mr. Martin further said: "We are proud to be Americans: not less proud than to be born Englishmen. We wanted to justify to you *why* we were Americans." As Chairman of the New York committee, he felt he owed a tribute to his *confrères* who had helped him in the little he had tried to do for our comfort. He and his committee had been glad to have us with them. He believed this was the first official visit of the Institution of Electrical Engineers to the United States. He trusted it would not be the last, and, if there was anything in their welcome that would induce us to come back again, he would say "please let it be as early and as speedy as possible."



SAMUEL INSULL.

Mr. Samuel Insull, Chairman of the Chicago reception committee, said that it was one of the greatest pleasures to receive us in the "Windy City," which,

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although it did not possess such magnitude as New York or such learning as Boston, was, he submitted, worth a visit, and in the short time at their disposal he and his friends had shown us all they could. He had special pleasure in receiving such important members of the British Institution, as he was himself a member, and it seemed to him that it was only meeting his own people from the other side of the Atlantic. "When I go to London, I go home," said Mr. Insull. There was no reason whatever, he proceeded, why the business in the large cities of Great Britain should not be on the same scale as in the United States. Was it not a crime for a city like London to have sixty-three different undertakings within its boundary? He characterised it as a technical absurdity. One lesson we should learn from America was to bring about a complete reversal in policy in Great Britain so far as the electric light industry was concerned. "Instead of your financiers looking upon it askance, it ought to be one of the greatest possible undertakings they should be engaged in. If this lesson is learnt in Great Britain," said Mr. Insull, "you will put us all to shame in the magnitude of your undertakings when the size of your cities is considered." He wished us all success, and was honestly sorry he could not go back with us.

Mr. Mullin remarked that although he did not come under the classification of chairman of a local committee, yet he would like to say a few words, as he felt there was one thing we should that night remember. We were all primarily gathered together for the work of the Electrical Congress. Very few of us realised that Dr. Kennelly had put in five hours a day in getting this Congress under weigh so that it would not be a failure. Mr. Weaver, by sound business management, brought matters to a happy consummation. Whatever success had been in St. Louis had been due to the unceasing efforts of these two men. Referring to the visitors, Mr. Mullin said he never met men from the other side without thinking of Washington Irvine's series of essays upon "the Old Home." They felt that when they went to England they went *home*. The whole Anglo-Saxon community was one great brotherhood, and he hoped his English friends felt as they felt. They had a sense of equity, and would give and take in fair proportion. He did hope that the visitors would carry back with them the feeling that their American kinsmen had done all that could be done for their happiness and enjoyment.

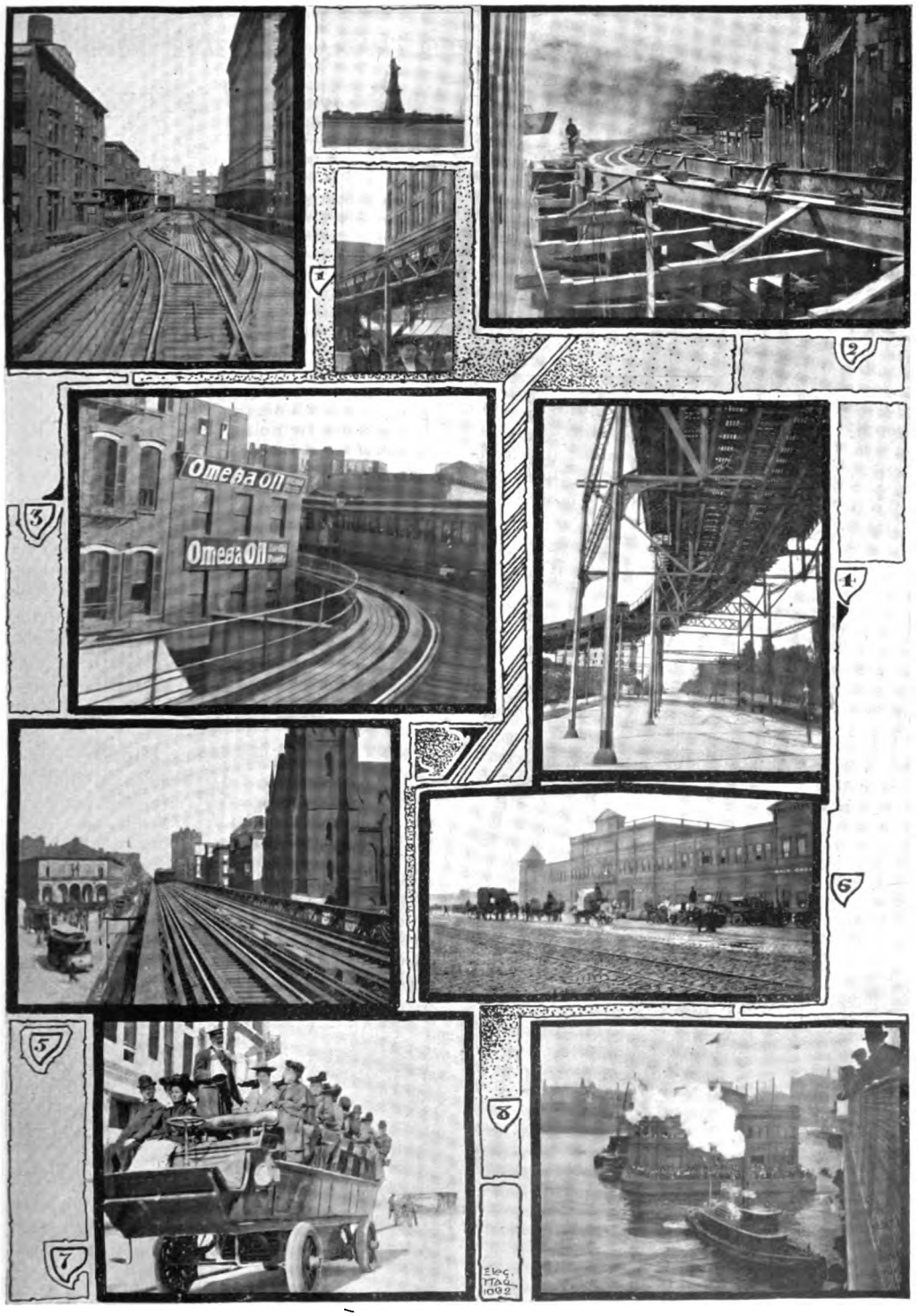
Mr. Bion J. Arnold trusted we had seen things that had interested us, and that we had learned something from the visit. He hoped we had been satisfied with the hospitality extended. (Cheers.) It had been their desire to give us a regular American welcome, and the pleasure which he and his friends had received in entertaining us was greater than we had in receiving it. He was glad that Prof. Elihu Thomson had been elected to the honorary membership of the Institution. President Gray had surprised and honoured the members of the American Institute very much by presenting to them a beautiful oil painting of William Gilbert explaining his electric experiments to Queen Elizabeth. That picture would be hung in their most conspicuous place. "And now, friends," said Mr. Arnold, "to-morrow you will leave us. We regret that you are going. Our hope is that you will return to us as soon as possible. We trust that you will find your loved ones at home ready to receive you with tears in their eyes but with joy in their hearts." (Great applause.)

President Gray's health was proposed by Mr. F. E. Gripper, and further on behalf of the English party he proposed the health of our American hostesses. "All admired the American ladies," said Mr. Gripper, "and greatly appreciated what they had done for the ladies of our party." (Chorus of hear, hear.)

At the conclusion of the supper a silver tea-service was presented to Mrs. Mullin, wife of Mr. E. H. Mullin of the General Electric Company, who, with her husband, accompanied the party throughout the tour, and was particularly active in looking after the lady members of the English party. Mrs. Mullin was loudly cheered on receiving the parting souvenir, and responded in a neat little speech. A gold cigarette-case was likewise presented to Mr. T. C. Martin of New York.

While the above dinner was in progress the visiting members of the Associazione

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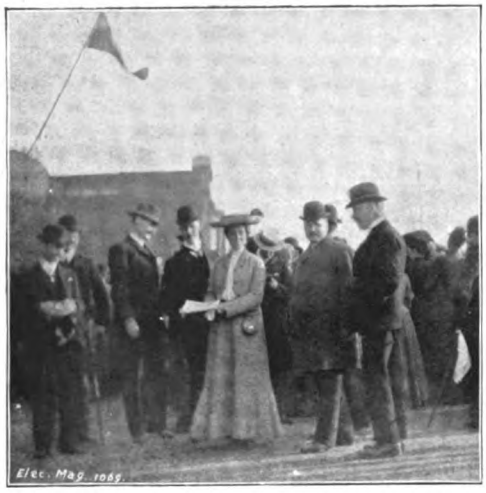


NEW YORK.

1. A bit of the Track on the 6th Elevated. *2. Method of carrying Train Lines during Alterations.*
3. A sharp curve on the 6th Elevated. *4. Near Central Park.*
5. Over Broadway, showing "New York Herald" Office. *6. "White Star" Depot.*
7. Sight-seeing Electric Automobile. *8. "Good-bye" to New York (taken from deck of "Baltic.")*

Photos by Prof. Cormack and Mr. Feilden.

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A GROUP ON THE LANDING-STAGE.

Elettrotecnica Italiana were holding a dinner at the Café Martin, in honour of Mr. J. W. Lieb, jun., of New York, Chairman of the general reception committee. Here Mr. Lieb was the recipient of a handsome silver bowl from the Italian visitors. He spent some years in Italy, speaks Italian fluently, and was the guide, philosopher, and friend of the Italians, who showed their gratitude in this manner. Mr. Lieb put in an appearance also at the British function, but had to hurry away to meet his Italian friends.

During my second visit to New York I put up at the Waldorf Astoria, as on my previous visit. Mr. Gray, Col. Crompton, and two or three other members of the party, I found, had decided to stay till the *Baltic* sailed, on October 5, and I made up my mind to stay also, as I had had no opportunity of becoming acquainted with the New Yorkers, and I desired to make some important business visits.

Return of most of the Party.

The great majority of the British party returned on the White Star ss. *Arabic* on Friday, September 23, and I, with others of those who were staying behind, went down to Pier 48 on the North River to see them off. Arriving half an hour before the boat sailed, I had an opportunity of running round the ship, and whilst she is undoubtedly a magnificent vessel, my fancy is still for the *Republic*. Perhaps I did not see enough of her, but I hear that the party had a very enjoyable time home. As she sailed from the docks, I managed to secure one or two good pictures.

A remarkable change in the weather took place on the evening of Thursday, the 22nd, the evening of the day we arrived from Mr. Edison's laboratory. It set in icily cold, with a keen wind blowing. Throughout the tour we had been used to very light clothes, and owing to the loss of my baggage I could not secure either my light or heavy overcoat. Such a sudden change in the weather was quite unlooked for. I was glad to recover my apparel the next day, and an entire change of clothing was necessary.

As far as official visits are concerned, I have nothing further to chronicle, and I have only now to say in this connection that I very greatly regret that we had not the time to make ourselves more familiar with the work that is going on in the United States in connection with electrical enterprise. We had crammed an enormous lot into an almost ridiculously short space of time, but, obviously, more time could not have been given to the undertaking for many good reasons, and I think myself fortunate, in any event, in having been one of the party. The whole tour, rapid as was the transit from place to place and brief the period of our visit at each point, was crammed full of interest and enjoyment.



DEPARTURE OF THE "ARABIC."

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It was hard work at that, and the wonder to me is that more members were not knocked up. Doubtless, however, the invigorating voyage across the Atlantic and the change of life and scene throughout the tour kept the party up to the sticking-point. Some men, of course, on a journey of this description get in more than others. I am told that I, with several other members of the party, worked every minute for all it was worth, and I was ironically asked on one occasion whether I thought I was taking a holiday. I confess to a feeling of weariness on the evening of the day the *Arabic* sailed; but holiday or no holiday, I was not dissatisfied with my general condition or with the liberal education the trip had afforded me.



PRINCIPAL THOROUGHFARE, ATLANTIC CITY, SHOWING TROLLEY SYSTEM.

A Little Relaxation.

I thought, however, it would not be bad to take a short rest, and made up my mind to pay a visit to Atlantic City, a place that has by this time become world-renowned. I accordingly took the afternoon train on Saturday, the 24th, and spent an enjoyable Sunday and Monday there. This place differs from any other seaside resort I have ever been in in my life. Most of the hotels and boarding-houses, as well as a great number of the business establishments, are built of wood, and along the sea-front for miles extends an enormous wooden promenade, called the Board Walk, flanked on one side by kiosks, stores, and places of entertainment of every conceivable character, and on the other by numerous sheltered recesses, band-stands, and places wherein one can rest. Two or three magnificent piers radiate from this side, and high-class entertainments are given thereon. Life is fairly free at Atlantic City. In the height of the season I am told that the tens of thousands of people lining the Board Walk are a sight to behold. Even later in the season, when I was there, it is fairly animated and interesting, but not rowdy, and the mixed bathing that was going on was conducted under the *ægis* of the town inspectors.

A Return Visit to Philadelphia.

Desiring to see something of Philadelphia, I left on the Tuesday morning, and this time thought I would try a change in hotels, putting up at the Little Hotel Wilmot, which is a dwarf to the Bellevue-Stratford, but it is comfortable and cosy and more like an English house than any place I have been into in the United States. Here I renewed my acquaintance with Mr. Turner, of the *North American*, was introduced by him to the courteous editor-in-chief of that publication, Mr. E. A. van Valkenburg, and accorded every facility, as I had been at St. Louis, for an inspection of the establishment, which I found conducted on the same smart and up-to-date business lines as the *St. Louis Star*. I stayed in Philadelphia until Friday evening, and took the opportunity of visiting the Curtis Publishing Company, one of the most remarkable publishing houses in the world. The circulation of the two great papers owned by this company, viz., the *Ladies' Home Journal* and the *Saturday Evening Post*, run to nearly a million apiece. The firm started with very small beginnings, and it is now

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one of the most perfectly equipped publishing houses in the world. The electrical installation is of a most up-to-date character, and Mr. John Hergesheimer, the very courteous chief electrician, who spent an afternoon in showing me round, explained the modifications that he had made to the plant, ensuring a maximum of work with a minimum of labour and power.

Visit to Cramp's.

During my stay I desired to visit Cramp's shipbuilding yard in order more particularly to observe the electrical equipment. I was surprised to find that I had a great difficulty in getting in here. My card was returned by the porter from the office with the observation that I could not be admitted. I however had come down to see these works, and determined not to go away without. Finally, I succeeded in reaching the assistant manager, who politely informed me that he would, under the circumstances, accede to my request, but pointedly remarked that when Americans visited England, they were denied admission to our shipbuilding yards, and that was the main reason why he had sent back my card. There were probably other reasons, but as the courtesy of this inspection was accorded me I have nothing to say beyond the fact, that, except in one of the new shops, I was struck with the comparative lack of electrical equipment. In the latest shop everything is on the most up-to-date scale. Whilst I was there the firm had a number of cruisers building for the United States Navy.

Fairmount Park, Philadelphia, is worth describing, but I have no space. Trolley-cars run around and through the beautiful park which is semi-wild and very picturesque.

I paid a duty visit to Independence Hall and signed the register, securing one of the celebrated bell trophies. On my return to the hotel on the evening of Friday, September 30, I received my invitation to meet the President of the United States at the White House. I would like to tell this in a little story all by itself.

PRESIDENT ROOSEVELT.

Some Impressions of an Able Personality.

WHAT is there so remarkable about President Roosevelt that he dominates whatever he comes in contact with? How is it that one who, while only a comparatively short time in office, has incurred the displeasure of the majority of the wealthiest wire-pullers in the country and of thousands of his countrymen is yet returned triumphantly to power?

I will give my impressions of Theodore Roosevelt as I met him at the White House, and perhaps it will explain the phenomenon a little. I received my invitation in a manner characteristic of the man. I was sitting in the Little Hotel Wilmot, Philadelphia, almost under the shadow of the great newly built Bellevue-Stratford. I had expressed to the managing editor of one of the leading Philadelphia dailies the regret of the British party of electrical engineers at not meeting the President on our recent visit to Washington.

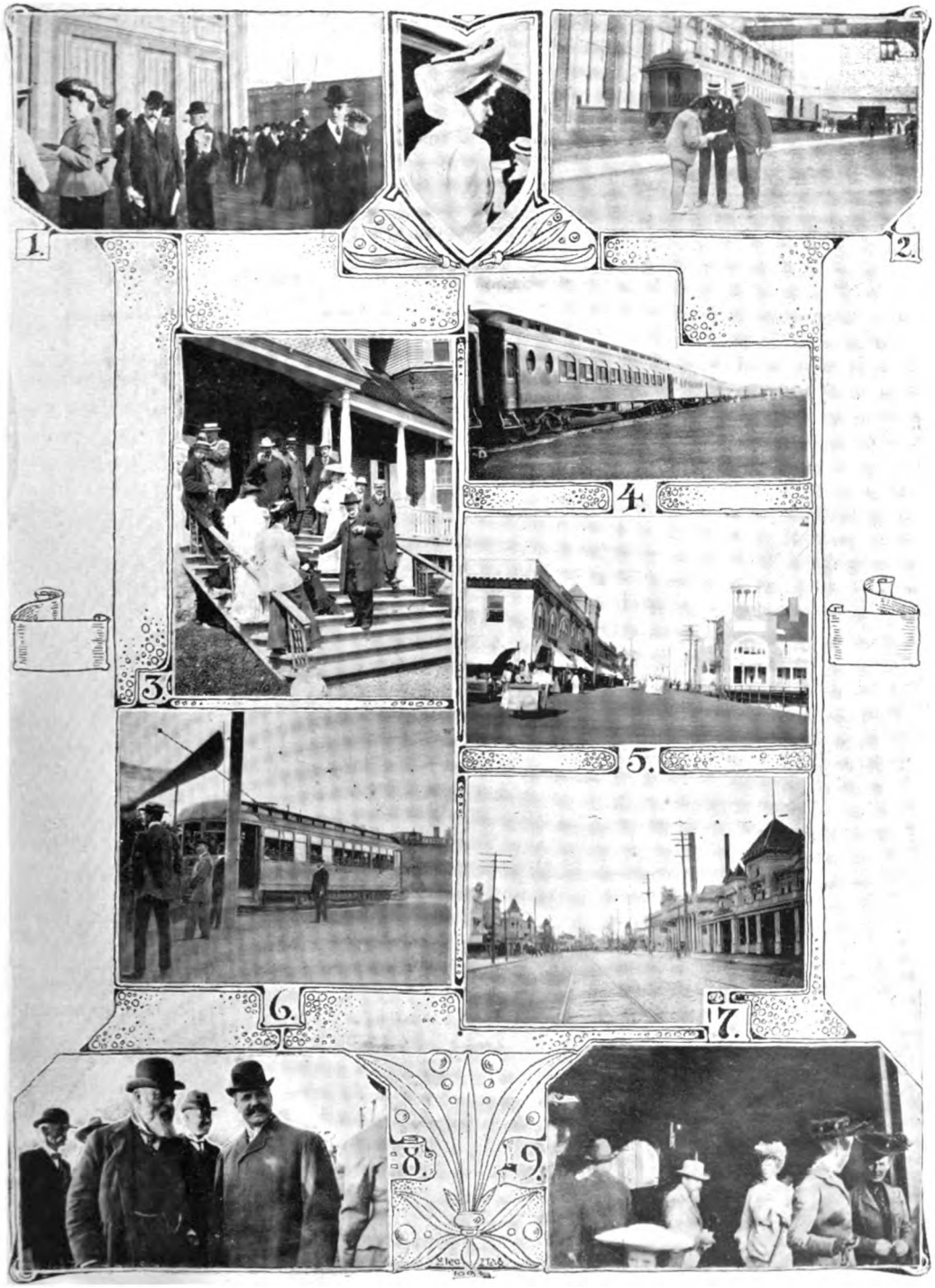
My wish was echoed in the proper quarter a little later in the day. I had just ordered coffee when a wire was put into my hand: "The President regrets not being able to meet you on the morrow (Friday) owing to a Cabinet meeting." Mr. Roosevelt's impression was that I was leaving for England at once. I telegraphed back that I was deferring my departure, and a message promptly came, within two hours, that he would be pleased to see me on Saturday at twelve.

An Audience at the White House.

At the appointed hour I was at the White House. With little or no formality I was ushered to the Green Reception Room, there to await the President. He had several special engagements between noon and one o'clock, and the room was half-full of people awaiting an audience. I regretted I was not to be alone with the President. I wanted to speak to the man himself, and not to the Head of the State.

I had previously, as diplomatically as circumstances would permit, let this be known. Did he know it? He seemed to know everything and everybody. I have never met the equal of President Roose-

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AT VARIOUS PLACES.

1. Mr. J. M. Wakeman, Mr. T. Commerford Martin and party on New York Landing Stage.
2. Prof. Steinmetz, Mr. Mullin and Mr. T. C. Martin at Schenectady.
3. Group of well known people on steps of Hunt Club, Montreal. *4. Our regal train at Niagara.*
5. The Board Walk, Atlantic City. *6. High-speed Trolley Car, Schenectady.*
7. Principal street, Coney Island. *8. Mr. Hammond, Mr. Gripper (in centre) and Mr. Wakeman at New York.*
9. Prof. and Mrs. Ascoli and company at the Italian Pavilion, St. Louis.

Photos by Messrs. Marshall, Hayashi, Barnes, Pyne, Whiting and Fcilden.

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velt. To me he was the most striking personality I have encountered in the United States, and during my sojourn I met many of the greatest, from Edison, the electrical wizard, downwards.

He came into the room where we were sitting, unannounced and unattended. As we simultaneously rose, he ran the party over with a rapid, searching glance. I was standing nearest him, but he passed me and directed his attention immediately to a man in the opposite part of the room. With a few quick steps he reached the man and grasped his hand, and his clear, sonorous voice rang out: "Mr. Blank, I am glad to meet you. I have to thank you for the great discrimination and care that you have exercised in the compilation of such and such report. If all our officials directed their talents and energies in the same channel and gave us similar information compiled in the same manner, the Consular service of the United States would be even more thorough than it is to-day."

The right thing in the right place. The words were uttered with force and dignity, and carried conviction; they also carried away the man who had something ready prepared to say, and had come many hundreds of miles to say it; he murmured his thanks and withdrew.

The President's Memory.

The President next directed his attention to a lady and gentleman standing near. The delight of the former was beyond expression when she realised that the President needed no reintroduction after a long lapse of years. He knew names, dates, events, even the smallest, it appeared to me, and he expressed himself again in a manner which left no trace on the mind that there was anything forced or artificial in the man or his methods. To each and every one in audience he had something to say which fitted the case in a manner which was surprising. No hesitancy, no forgetfulness, no loss of time, not much for each, yet all went away satisfied.

When the door had closed on all but myself, he came over to me and the grasp of his hand was unmistakable. "You are the Englishman, Mr. Feilden." I had no introduction, he knew me as he knew every one else in the room, and obviously he had reserved me to the last. I considered this a great compliment to my country, as I had the opportunity of a few quiet words with the President.

As I had given my word to his secretary not to publish his views, I refrain from details of the conversation, but as I left the White House I said to myself, "It will be a fortunate thing for the United States if Mr. Roosevelt be elected for another term. He is not the kind of man to rest content with present achievements, no matter how important they may be. He is progressive at every stage, and the accomplishment of one worthy object will, in his case, I think, but afford reason for attempting still greater things."

His Forceful Character.

In my meeting with him I was impressed not alone by the interest he displayed in what I had to say respecting the results of the Electrical Congress, but by the simplicity and democracy of the man. There was no ostentation, no assumption of official dignity, but just a strong man with a mind broad enough to feel an interest in all matters brought to his notice. I was particularly struck with the forceful, incisive manner of his treatment of men, and also by the versatility he displayed in dealing with a variety of subjects in a remarkably short period of time. He treated me with a degree of cordiality which surprised me, but I had the opportunity of discovering that this is his customary manner, and was not forced for the occasion. When leaving, he shook me by both hands with a genuineness which was as unmistakable as his greeting. He looks the man to whom he is talking straight in the eyes in a manner that ensures his own frankness, but must be trying to one who is not prepared to be equally frank in return.

The general impression made upon me by the President was one of remarkable strength and force—mental, moral, and physical. The simple reason, in my opinion, why Mr. Roosevelt has been returned to power is that the United States realises that it has the right man in the right place, and could just now find no better. In this contest even the usually all-powerful trusts have found themselves impotent.

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AT NEW YORK ONCE MORE.

I LEFT the White House in company with the affable and accommodating representative of the *Philadelphia North American*. As I had not had time to visit the tomb of President Washington at Mount Vernon on my last visit, I took the present opportunity of repairing this omission, and in the company of my newspaper friend, took the high-speed trolley-car from the United States Printing Department. The ride to Mount Vernon was a very interesting one, crossing the Potomac River, and through some very beautiful scenery. The two hours I spent at Washington's old home were two of the most interesting I have ever spent in my life. A wonderful collection of Washington relics is here. I am told that all the most sacred and precious things which were distributed at the great President's death have been recovered, and that they occupy the same place in his old home as they did in his life-time.

I was back in the city about five in the evening, made a few purchases, and took the night sleeping-car train direct to New York. A curious thought struck me as I left Washington Station. I had this day gazed with reverence upon the tomb of America's first and greatest President, and shaken hands with her very popular latest President—within the space of a couple of hours.

Arrived at the terminus, I thought I would try a new hotel, and put up at the Marlborough, which had been recommended to me as a good class place with no princely prices. I found it in every way comfortable. They give you here first-class accommodation and an excellent cuisine at fair charges. The serving was good, in fact better than I had had throughout the States, and if ever I revisit New York, as I hope I shall on more than one occasion, I shall go straight to the Marlborough. The management was most obliging, and did everything possible and reasonable for my comfort. This hotel caters for business men, and knows how to treat them. With regard to the serving in the dining-rooms of the hotels in the United States I cannot help expressing my plain views, which are that in some respects it is the worst I have experienced in *any* country, and I have done some travelling. Members of our party have had to wait oftentimes for twenty minutes before being served with a simple dish at the very best hotels. One of the chief waiters informed me that the fault largely lay in the fact that the kitchens were so far away from the dining-rooms; whatever it is, it is wrong, and most unfavourable comments were made by many of our party. In consequence many got their meals at restaurants outside. I do not refer, of course, to the banquets provided, but to the private meals ordered. America is certainly far behind the old country in the matter of expeditious catering at the best hotels.

The day after my return to New York, Sunday, October 2, was unfortunately a wet and dreary day. It brightened up slightly in the afternoon, but was very cold. I tried a car ride over Brooklyn Bridge to Coney Island. It is marvellous how the land all round Coney Island has developed. Building operations are going on everywhere, and whereas only a few years ago two or three houses stood there, to-day there are many hundreds and likely to be thousands. I found Coney Island practically deserted, and its war-paint off. I was glad to get back to my dinner at the Marlborough.

I stayed in New York until Wednesday, October 5, when the *Baltic* sailed, having booked my passage a few days previously. During the few days I remained in New York, I took occasion to visit one or two of the big newspaper establishments, and was received with the same invariable courtesy as had been extended to me in other cities of the Union. I also made it my duty to become better acquainted with some of the good fellows I had met on the tour, and to pay Mr. Pope, the ever obliging, resourceful, and genial Secretary of the American Institute of Electrical Engineers, a last visit, when I applied for membership of the Institute.

One of the happiest memories of the courtesies extended to me by journalistic friends that I carried away with me from America is that of my second meeting with Mr. Charles W. Price, the Editor of the *Electrical Review*, of New York. By his kind invitation I was introduced to the Lotus Club, being presented with a membership ticket for a week. I spent a very pleasant evening dining with Mr.

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"The Seven." The last of the Party, returning on the "Baltic."

Price and the Traffic Superintendent, Mr. Daniels, of the New York Central, who, hearing that I was likely to give a lecture upon the American trip in England, was good enough to present me with a number of beautiful pictures of scenes on the line, and also with some lantern slides.

A few words as to my impressions of New York. To one who wishes to inspect the city rapidly and practically thoroughly, that is, to see all the most notable sights, and to get a good acquaintance with pretty well everything worth observing, it is advisable to take one of the sight-seeing electric automobiles, which run twice daily to different parts. These great motor-cars accommodate about twenty-six people. They are accompanied by an accomplished guide, who, with a megaphone, explains everything thoroughly. New York, like London and all great cities, has its bright aspect and its bad side, but to me it seemed that in this democractic centre, both were strongly intensified above anything else I had observed in any other great city of the world. Millionaires' Row personifies at once the acme of wealth, comfort, and superlative extravagance. The great business and other magnates here vie with each other in the splendour and appointments of their edifices. Money here is lavished in an extraordinary manner, and the price of one palatial residence, out of hundreds that stand in this remarkable spot, represents often a sum "beyond the dreams of avarice." Over the poor and vicious portion of New York I would sooner draw a curtain; it is appalling in the extreme. There is no use in my dilating upon the police system of this great city, or on the moral tone of the municipal transactions. Tammany is a by-word, and I will let it go at that.

Central Park, New York, is well worth a visit. The grounds are superbly laid

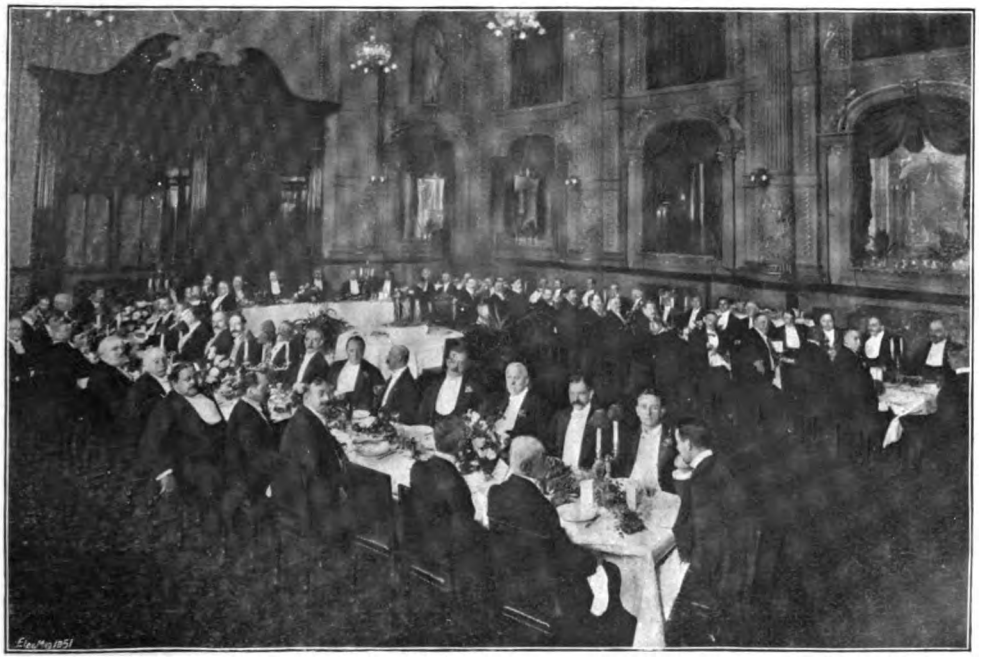


A friendly chat on the "Baltic." Sir William Ramsay and Dr. Mills.

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out, and one could spend a day or two there, without exhausting its attractions.

The great thing one has to avoid in New York is being run over. It is not a very easy thing to dodge the electric cars at the junction of streets, particularly where half a dozen converge on a square. Fortunately, I escaped only with the loss of a hat. With all its drawbacks, however, New York is a splendid city, and I should not at all mind living there. I therefore say to it and its citizens "Au revoir, and not good-bye."



DINNER TO DR. LEE DE FOREST AT HOTEL CECIL.

The morning I sailed on the *Baltic* broke fine, with a fairly strong breeze blowing. It is almost impossible to describe in words the majesty of this magnificent vessel. From the boat deck I viewed her gigantic proportions. Everything around seemed diminutive in comparison. It was easily discernible how considerably she exceeded anything else upon the sea. The *Republic*, splendid vessel as she is, seemed to me to dwarf into relative insignificance. The *Baltic* is 24,000 tons register, 725 ft. long, 75 ft. broad, 49 ft. deep, and her displacement loaded is 40,000 tons.

We steamed away under the most favourable auspices, and had a most enjoyable journey across the Atlantic. A curious thing was in evidence whilst on this journey. Before sailing from England it was jocularly suggested that probably about seven of us might return. Strange to relate, on counting up the forces of the electrical party on the boat, we found that there were exactly seven of us, viz., Mr. R. Kaye Gray, Colonel Crompton, Mr. John T. Connolly, Mr. Bates, Mr. Duddell, Mr. Hope-Jones, and myself. Among the distinguished passengers on board were Sir William Ramsay, Dr. Mills, Mr. John Redmond, the Earl of Yarmouth, Dr. Lee de Forest, and several other notabilities. We arrived off the Bar in a fog, and had to lay-to all night, arriving at Liverpool at 7.30 on the morning of Friday, October 14. From here the journey to Euston seemed to take a ridiculously short time after the enormous tracts of country we had crossed by train in the United States. With the vivid remembrance of all the courtesies that had been extended to me during the memorable tour I had undertaken, and of the many and wonderful sights I had seen in the great Republic, I still felt

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glad to be once more in dear, dirty old London.

As an indication of the thoughtfulness of our American cousins, shortly after my return to England I received an invitation from Mr. Franck Z. Maguire, of the American De Forest Wireless Telegraph Co., to the dinner given in honour of Dr. Lee de Forest, at the Hotel Cecil, the night before his return to the States. I was glad again to meet Dr. de Forest, and I am sure that all the nice things said about him by Sir William Henry Preece, who presided, and by the enterprising Correspondent of the *Times* who had used the De Forest system with such success, were well deserved. The dinner was a notable gathering, largely representative of scientific thought and work. I am presenting in this issue a flashlight picture of the company present.

I have now concluded my story of the American tour, and, while I hope that it possesses elements of interest not only to those who were of the party, but to the great many others who did not take the journey, I feel that it is altogether imperfectly presented, for this reason: to give the matter in its best aspect would be to include exhaustive details of not alone the various power houses, institutions, and places of interest visited, but to illustrate and describe the workings and scope of all the principal electrical concerns in the towns and cities we passed through. I should like to have treated the whole subject on a far broader and more generous lines, but to do this would have occupied a book as large as a volume of the "Encyclopædia Britannica." I therefore must satisfy myself and my readers with what I have here set down—which is a true narrative of events as they transpired with impressions and such data as I thought to be of essential interest.

Robert Kaye Gray.

It is with a considerable degree of pleasure that we present our readers with a plate portrait of Robert Kaye Gray, Esq. As the President of the Institution of Electrical Engineers, he was leader of the Tour Party and an imposing personality at that. He quite captivated our American friends by his powerful presence, and his almost electric influence made fraternising with our hosts an easy matter for us. The post of official spokesman at banquets and receptions, arduous as it would have been to any other, was filled by him with ease and grace. He voiced the sentiments of the party on all occasions with apt expression not untouched by humour, despite the repeated calls upon him. He was the most conspicuous character of the party, and as President and guide his dignity and geniality were undoubted. Mr. Gray is head of a great cable organisation—the India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.—whose annals are written in the thousands of miles of submarine cables linking the world's continents, circumscribing the earth and annihilating distance. Small wonder that Americans hastened to honour the man controlling so powerful a corporation, and we were indeed fortunate in having such a figure-head on so momentous an occasion.



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VIEWS OF NOTABLE AMERICAN ELECTRICAL ENGINEERS.

(Specially contributed to "The Electrical Magazine.")

Delegates to the Congress.

Prof. Elihu Thomson.

ALL the members of the party will pleasurably recall the personality of Prof. Elihu Thomson. Although he needs no introduction to our readers, a short biographical reference will be a fitting prefatory to his views.

He was born in Manchester, England, in 1853, and as a child of five was brought to the United States. Educated in Philadelphia and graduating from the Central High School in 1870, he displayed a marked aptitude for the study of electricity. In 1880 he entered the electrical field and has established for himself an enviable record in that sphere. As a result of his early invention of the arc-lighting dynamo, public electric lighting became commercially practical. In company with other engineers he was instrumental in laying the foundation of what is to-day one of America's greatest electrical corporations, the General Electric Co.

It was a great encouragement to those on whom fell the work of the organisation and conduct of the Congress that so many representative, scientific and technical men from abroad were with us at St. Louis. This applies particularly to the large body of British and Italian engineers.

Some were friends of years past; many new ties were formed. Despite drawbacks, of which we are quite conscious, we feel that the transactions of the Congress will form a valuable addition to the literature of our profession. The work of the Chamber of Official Delegates will, we hope, soon bear fruit in the appointment of an International Commission. The time was short and the wonder is that, in the midst of so many distractions, the attendance on the meetings of the Sections of the Congress were so full. Contrary to anticipation we were favoured with most propitious weather conditions, without which the social gatherings and reunions would have lost much of their charm. This meant much to the ladies, whose presence was such a welcome addition.

We can never forget the genuine good fellowship which was a marked characteristic of both the technical and social gatherings in which our British friends took part. The leave-taking came all too soon.

That the long journey was accomplished without serious delays or setbacks is a satisfaction to all.

Dr. A. E. Kennelly.

Among the Government delegates was Dr. A. E. Kennelly, past president of the American Institute of Electrical Engineers. He is now professor of electrical engineering at Harvard. He was early engaged in telegraph work, and, like numerous electrical men in America, drifted towards Edison's laboratories, which he entered in 1888. Dr. Kennelly has held his present position since 1892. All who were privileged to meet him will recall his cordiality and genial manner. His personal impressions which we append will be read with interest.

The electrical engineers of the United States were delighted to have the opportunity of welcoming their *confrères* from across the sea on the occasion of the circular tour last September in connection with the International Electrical Congress. I spoke to many of the American electrical engineers upon the subject of this visit, and the opinions expressed to me were unvaryingly of pleasure in meeting, and of a desire to add to the entertainment of our foreign visitors. I say foreign in the geographical sense, although this adjective is almost meaningless electrically. All over the world electrical engineers have the same international units and formulæ. Even the oceans, that divide continents, may be considered, in the light of Hertzian waves, to *connect* electrical engineers.

The advantages accruing to us in America from the visit of our trans-Atlantic collaborators has not been merely a pleasant trip, a successful convention and a happy recollection; but also the stimulus that comes from the reception of views originating under other skies, auspices, and conditions. It is surely by the union of different ideas, derived from differing standpoints, that new and improved ideas are created.

The International Electrical Congress may be said to have constituted a temporary union of Institutions of Electrical

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Engineers from different lands. Its transactions will have been enriched by contributions of papers and discussions from representatives of those different institutions. May we not look forward to a time and a plan under which this temporary union may some day become permanent; that is, when electrical engineers will either belong to one international institution, whose branches are found in different countries, or that they will belong each to their own institution, while these institutions will be interconnected in some international union? Sooner or later, world-wide problems in engineering may call for universal co-operation in execution; and the interchange of thought, concept and action between engineers of different countries might be expected to succeed more readily than diverse, diffuse, and disconcerted endeavours.

Speaking as but one of the American electrical engineers I deem myself most fortunate in having met so many well-known and charming personalities among the visitors that the circular tour brought to our shores to St. Louis.

Prof. H. S. Carhart.

Prof. H. S. Carhart stands in the front rank of American physicists. Born in 1844 near Albany, N.Y., he graduated at the Wesleyan University in 1869. He has been closely associated with many notable Expositions at Paris in 1881, Chicago in 1893 and the Pan-American Exposition 1901. As president of the American Electro-Chemical Society he figures prominently in electro-chemical circles. He was chairman of Section C (Electro-Chemistry). Judging by his remarks he was well satisfied with the work of the Congress.

The opinions heretofore expressed relative to the St. Louis Electrical Congress have been so uniformly favourable and so much to the point that further comment seems to be quite unnecessary. Personally I was well pleased with the results. It was particularly gratifying that the attendance of accredited delegates from the leading Governments was so good. The action of the Chamber of Delegates in asking for a permanent Commission to report upon changes in electrical units, if any, and to secure uniformity of laws relating to units of electrical measurement, meets with my hearty approval.

Prof. W. E. Goldsborough.

Professor W. E. Goldsborough, chief of the Department of Electricity at the St. Louis



PROF. W. E. GOLDSBOROUGH.

Exposition, had a difficult task to accomplish in the classification and arrangements of the electrical exhibits. He has been associated with the Purdue University since 1893, and since 1897 has been professor of electrical engineering at that institution. He attended the Congresses of Chicago and Paris. Under his direction an amount of experimental work on arc lamps and carbons has been done in the Purdue electrical laboratories. He was vice-president of the American Institute of Electrical Engineers.

His views may be taken as representative of the attitude of the Exposition authorities.

From the standpoint of one who has of necessity viewed the matter in close contact with the Exposition management, the International Electrical Congress of 1904 can safely be pronounced a magnificent success. Viewing it from the standpoint of a member of the American Institute of Electrical Engineers, the Congress came fully up to my expectations and in many particulars exceeded them. From the standpoint of a member of the Institution of Electrical Engineers, I am very glad we were so well represented and showed so clearly to our friends of the American Institute of Electrical

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See p. 145 for Report of Congress Meetings.

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Engineers that we appreciated the many courtesies they have extended to us, both in meeting with us in England, and in entertaining us in America. As a member of the International Electrical Congress I feel a keen sense of pleasure from my connection with it. The Congress comprised a most enthusiastic and fervent body of workers, who were appreciative of the arrangements which had been made for them and were untiring in their efforts to make the meetings of the Congress in every way profitable to all concerned. I am quite sure the Congress surprised itself in the amount and quality of the work which it finished up and has for its record. The Congress is a good landmark by which to measure progress in our professional work, and in its association with the Chamber of Delegates bids fair to have an enduring life which will make most potently for progress and development of the better kind. However it may be viewed, the Congress seems to stand the test, and will go down in history ranking high among Congresses of similar character. To its president, its secretary, its treasurer, and the many men who clasped hands across the seas to make it a success, electricity owes a debt of gratitude.

CHAIRMEN AND SECRETARIES OF CONGRESS SECTIONS.

Dr. Louis Bell (Section D).

Dr. Louis Bell, born in 1864, has figured prominently in American electrical development. He became professor of physics and applied electricity at Purdue University in 1889, and editor of *The Electrical World* 1890. He has since been actively engaged in power-transmission work and was secretary for Section D at the Electrical Congress. He gives his impressions on the work of the Section as follows:



The most striking feature of the deliberations of this Section was the advanced stand by common consent taken with respect to high voltage. It was evident at once that the engineers devoted to this sort of work already had come to look upon transmission voltages of 10,000 and below as ultra-conservative, and upon those between 10,000 and 20,000 as makeshifts, perhaps excusable in the past but not to be seriously considered in the large work of the present and the future. In fact, the engineer in charge of the largest high-voltage network in the country, and the world in fact, did not hesitate to say that he considered working at 40,000 to 50,000 volts positively easier than at half those pressures, on the ground that for equal energy transmitted the currents, on the absolute magnitude of which some of the most serious line disturbances depend, are proportionately less on the systems of higher voltage. Of course success depends mainly upon the quality of the line insulation, a topic upon which several papers were read. Rational insulator design has made great progress of late, thanks to the experience accumulated in commercial work and to experiments conducted with insulator design in view. The present tendency is away from the insulators of enormous dimensions which came into vogue a year or two ago, toward structures of moderate size and of the best attainable material. Porcelain and glass are both in use at pressures of 40,000 volts and upwards, but the majority of engineers prefer the porcelain. Another subject which was considerably discussed was the use of steel poles or towers in high-voltage lines. The consensus of opinion rather favoured their use, although rather on theoretical grounds than as a result of experience. Most of the existing high-voltage lines use wooden poles almost exclusively; and the use of steel towers, which has been tentatively undertaken, has not yet the approval of experience. With improvements in insulators practice is likely to tend toward a further use of metal poles, cross arms and pins. One of the most entertaining discussions in the Section was upon lightning arresters, in which it must regretfully be stated that the reputations of these appliances were badly damaged. One might almost say that the amount of lightning arresters is inversely as the voltage, and that the satisfaction reported from their use was

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inversely as the amount of lightning encountered. The most important tendency in the practice of power-transmission systems is that toward the union of generating plants and lines into extensive networks, reproducing on a magnificent scale the advantages already found in networks for general electrical distribution.

Dr. E. L. Nichols (Section A).

The chairman of a Section is hardly qualified to speak concerning the work of the Congress because his duties confine him during the entire session to the single Section over which he presides. The programme of Section A was interesting throughout, and in some respects important. The attendance was all that could have been expected when one considers the number of attractive papers being read simultaneously in other Sections. It was impossible to do full justice to the matters presented for lack of adequate time and on account of the altogether unsuitable room assigned to the Section; and the same criticism holds with respect to other Sections of the Congress. I believe that the Electrical Congress at St. Louis, in taking the first steps looking to the organisation of a permanent international committee on standards, accomplished something for which it will long be memorable.



Carl Hering (Section C).

Mr. Carl Hering, who was Secretary for Section C (Electro-Chemistry), has contributed much to the success of the American Electro-Chemical Society. His has been a brilliant electrical career, and he has occupied many prominent positions. He has also been officially associated with the great electrical gatherings of the past. He reported on the famous Frankfort-Lauffen plant, and prophesied on that occasion the adoption of the same system at Niagara Falls. Needless to say his foresight was subsequently realised. His remarks on the Congress are of considerable interest.

I consider the International Congress of 1904 at St. Louis to have been in most respects a great success. The large number of papers seemed to have been as a rule of a high order, and included fewer of the kind, so commonly found, which may be classed among mere advertisements, descriptions of impracticable schemes, or rehashing of papers which had already been published. They seemed to belong more to practical engineering than to pure science or theory. The work of the official delegates in recommending the establishment of a more permanent international commission to bring about international agreement on units and allied subjects, seems an eminently satisfactory solution of a very difficult and important problem. The differences existing at present in the values of some of the units in different countries are most unfortunate, even though they are too small to be of great importance in the industries. Such agreements ought to be virtually established prior to such a meeting, leaving to the official delegates merely the final official agreement and the settling of minor differences. Such virtual agreement did not exist prior to this Congress, hence any official agreement at this time might not have been universally satisfactory.



A. H. Armstrong (Section F).

The discussions at the Congress and particularly those at the Railway Section lead me to form the opinion that railroad engineering in the States was conducted upon a much more conservative basis than European projects, especially those upon the continent. In the States we have been often accused of installing, operating and discarding a type of apparatus before the preliminary work of drawing up the necessary plans would have been completed by a European engineer. In

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the early days of the development of electric traction work our impatience to better our traction facilities may have laid us open to such a charge; but without in any way departing from a progressive policy, the American engineers in the discussions at St. Louis were much more conservative in their statements and proposed fewer schemes of doubtful expediency than our cousins from across the water. The opinion still appears to be rife abroad that the rotary converter is a piece of apparatus to be avoided, and the necessities of long-distance electric railway distribution have led to the installation of many railway systems of questionable performance compared to the operation of the direct-current motor fed from a rotary converter alternate-current generator combination.



The alternate-current motor of course commanded the complete attention of all engineers, both European and American. As operating information was confined to one or two roads from abroad, and a single instance in the States, that of the Schenectady-Ballston line, any discussion on the comparative merits of such motors and direct-current motors was necessarily limited to the representatives of the large manufacturing companies. The development of this motor is being watched with the keenest interest both at home and abroad, and at the next International Congress will undoubtedly justify many of the expectations of its adherents.

A great contrast in the point of view of home and foreign engineers was the natural result of the method of capitalising such systems. The huge combination of interests in the States has led to electric railway city and suburban systems of large extent, calling for generating stations approaching 100,000 kw. in capacity and distributing systems proportionally great. The European engineer, on the other hand, has only commenced to instal isolated roads. His problems are comparatively small in extent, which had led to the introduction of many refinements, of which the storage battery is an instance, which have not been considered necessary in America. The value of the interchange of ideas brought about by the International Congress cannot be over-estimated, and all those attending learned something of value to themselves in exchange for ideas of their own, which were valuable to others.

F. W. Jones (Section G).

The Chairman of Section G. (Electric Communication), Mr. F. W. Jones, has had exceptional experience in telegraph work. In 1861 he became Manager of the Telegraph office of the American Telegraph Co. in Kentville. Since then he has occupied many prominent positions and done much good work towards the improvement of telegraphic communication. He was the first to ascertain that frequent electrical disturbances on telegraph circuits are due during the winter to electrified snow particles and during the summer to electrified sand particles being driven by the wind through the wires, the snow or sand in passing giving the wires a static charge which sought the earth at the lowest point of resistance. On the formation of the Post Office Telegraph Co., 1885, Mr. Jones was appointed electrical engineer and has occupied that position ever since. Telegraph engineers will doubtless read his remarks with interest.

It is my opinion that the publication of the papers which were read before the various Sections of the International Electrical Congress at St. Louis will be of large permanent interest, not only to electrical engineers. but to all interested in the progress of electrical science. While Section G, of which I had the great honour to be chairman, was favoured with a generous number of exceedingly valuable papers, I cannot rid myself of the feeling that much more could have been contributed, particularly in relation to telegraphs and telephones, by electrical



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engineers in England, and upon the Continent of Europe, if they had been less hampered by the governmental "red tape" to which those systems of electric communication are subjected. To illustrate this, I took the liberty a few years ago of writing directly to Dr. Stephan, in Berlin, for some very general and ordinary information about the operation of underground cables in Germany, and was surprised from his very courteous reply to be informed that it would be necessary for me to apply to the German Government, through the Secretary of the United States at Washington, in order to secure the desired information, as his Government could not recognise the request coming directly from an official of a private corporation. This incident has inspired me with a fear, as above intimated, that some such a technicality has prevented various Sections of the Congress from being more fully enriched by the valuable information which many Government telegraph and telephone officials possess.

There were some very happy exceptions, however. One was in the valuable information conveyed by Mr. John Hesketh, of Queensland, Australia. He represented the Commonwealth of Australia in Section G, and was also honorary chairman of the section. However, I believe that the promoters of the Electrical Congress are to be congratulated upon its great success, and it has fully demonstrated the great value of an international exchange of ideas by representative electrical engineers.

Dr. W. J. Morton (Section H).

The work of the Electrical Congress was an inspiration for good to every man whom I have met who took any part in it. It was particularly gratifying to a large number of medical men who have long been hoping for the day when the applications of electricity in medicine should be put upon a purely scientific footing. It showed a most broad-minded spirit when the electrical experts of the country, through their accredited officials, extended the hand of scientific fellowship to the medical man in the shape of a Section devoted to electro-therapeutics. I am personally but voicing the thankfulness that many physicians have expressed to me in regard to this action on the part of the Congress. We medical men have long been under a great debt of gratitude to many distinguished electrical experts who have stepped aside from the purely scientific and industrial aspect of their studies, and have joined hands with us to solve some of the problems relating to the connection of electricity with biology. This particular Congress will not easily be repeated, and will set a standard and precedent which will be a continual stimulus for the excellence of the next one.



CHAIRMEN OF LOCAL RECEPTION COMMITTEES.

C. L. Edgar (Boston).

A NUMBER of prominent American electrical engineers, though not attending the Congress, have kindly given us their views. Among these is Mr. C. L. EDGAR, an electrician who has probably done more than any other man towards the consolidation of central-station interests in the United States. He worked in Edison's laboratory in 1883, and since has occupied varying positions under different Edison Companies. Rising to be general manager and vice-president in turn, he was subsequently elected president of the Boston Edison Electric Co., the position he now holds. He



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has done much good work for the National Electric Light Association, of which he was president in 1904. He thus speaks of the Congress and the tour:

I was not able to attend the International Congress, and therefore cannot speak from personal experience about it. Every one with whom I have talked has stated that it was a great success. The idea of the tour through the country was a happy inspiration. It enabled the English engineers to not only become acquainted with the membership of the American Institute of Electrical Engineers but also to meet, in the various large cities which they visited, the leading men of the country who are engaged in electrical enterprises in general, but many of whom, of course, are not engineers and are therefore not members of the American Institute. It also enabled the various local committees to return, as far as they were able, a few of the courtesies which had been extended to them whenever any of them happened to visit Europe. Personally I feel that, although I assisted in every way that I could, I have not yet anywhere near paid the debt which I owe to the English engineers for the many courtesies shown me during my various visits to your country.



G. S. Dunn.
(Secretary, Section E.)



T. C. Martin (New York).

Of the Chairmen of Reception Committees we have pleasing recollections of Mr. T. Commerford Martin, the Editor of *The Electrical World and Engineer*. Mr. Martin also hails from Edison's laboratory, which he entered in 1883. Since 1887 he has held his present position and is senior past president of the American Institution of Electrical Engineers. He accompanied the party throughout the Tour, and his ideas on the value of the same make instructive reading.

As to my impressions of the recent Tour and Congress I can only say that I believe thoroughly in the great practical benefit that must accrue from such affairs, and that I wish Englishmen in greater numbers could visit this country in order to see what we are doing and to ascertain our reasons for doing it, as well as the respects in which we differ from our friends in Europe. Every American engineer, electrical or otherwise, considers it part of his training and education to visit Europe; and it seems to me that equally it should be regarded as part of the equipment of an English or a European engineer to visit the United States. This is being done by increasing numbers of men, and I think that one of the results is not only to bring about more universal standards of practice, but to cultivate mutual good understanding and personal friendship. I think, however, that the recent trip was altogether too short and too hurried to do much good in a technical sense. This, however, the Congress tended to correct, and the presence of so many engineers from all parts of the world tended to make that meeting one of the most useful of the kind.

The Congress embraced over 2,000 members, from whom 152 papers were received, and a large actual attendance gave weight and authority to the discussions. The plans outlined for future Congresses, so as to give them official sanction and to help the enforcement of their decisions, were also admirable. It seems to me that one practical outcome of the visit of the British Institution might well be a larger enjoyment of membership in it by Americans and the admission of many Englishmen to the American body. Such an interchange of membership should be rendered feasible

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without a great increase of expenditure by the members or the societies, and the excellent Transactions of both would thus enjoy wider circulation.

***G. D. Shepardson* (*Montreal*).**

It gives me great pleasure to express to my British friends the satisfaction given me by meeting a number of those whom I had known by reputation for years. It was certainly a great privilege to grasp the hands of the veteran electrical engineers whose writings have done so much to further the development of science, and also to appreciate that the younger men will keep up the good example. The thought uppermost in my mind throughout the meetings was the minimising of national differences among men of science. While we naturally look through different glasses on account of environment, yet men of science are most interested in matters which recognise no nation's boundaries. The fellowship which is so intensified by these international gatherings seems to me to be one of the strongest forces tending to universal peace among nations. May it not be that the strong friendship among engineers and other men of science shall eventuate in relegating the science of war to the field of pure science rather than applied?



***W. A. Layman* (*St. Louis*).**

As to the Congress I regret to say that my duties as host prevented more than a superficial insight into it. We all had the feeling, however, that the Congress was a great success. I am sure this was the case if judged from the fraternal results alone derived. Of the value of the technical material submitted, I can only say I understand it to be fully up to expectations, and I await with much interest the official publication, which it is my expectation to review most carefully. With respect to the participation of your English engineers I may say we were all much gratified. The number of English members attending was not only satisfactorily large, but the very cordial spirit of their participation was greatly appreciated. The writer was much pleased to receive a personal letter from President Gray of your English society, expressing appreciation of such courtesies as were extended him. Another most pleasing act on the part of the English delegation was a telegram sent on their arrival in New York City *en route* home, expressing at some length their enjoyment of the trip, and their thanks for our efforts to entertain them.

Our local committees, as perhaps your members appreciated, laboured at some disadvantage by virtue of the long continued series of entertainments for visiting delegations arising in connection with the Exposition prior to the Electrical Congress, but you may be sure any failure on our part to properly take care of our Congress guests was due to causes beyond our control. If the efforts made resulted in pleasure to our guests we certainly may feel fully rewarded, for we planned a larger degree of hospitality than the immediate circumstances of Congress week enabled us to take care of. I do not refer to a more liberal hospitality in the way of public functions, but rather a more liberal attention to your members individually. In this respect we were somewhat disappointed, but trust your members in all their material wants were not seriously affected.



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The Report of the Chamber of Delegates.

THE Chamber of Delegates which met in camera on Monday afternoon, September 12, presented its report on Saturday the 17th, at the close of the Congress. Dr. A. E. Kennelly, the Secretary of the Congress, referred briefly to the reports of the Committees on International Electro-magnetic units and International standardisation of electrical apparatus and machinery. These reports are given below :

International Electro-magnetic Units.

The sub-committee appointed September 13, 1904, begs leave to suggest that the chamber of delegates should adopt the following report :

It appears from papers laid before the International Electrical Congress and from the discussion that there are considerable discrepancies between the laws relating to electric units, or their interpretations, in the various countries represented, which, in the opinion of the chamber, require consideration with a view to securing practical uniformity. Other questions bearing on nomenclature and the determination of units and standards have also been raised, in which, in the opinion of the chamber, it is desirable to have international agreement.

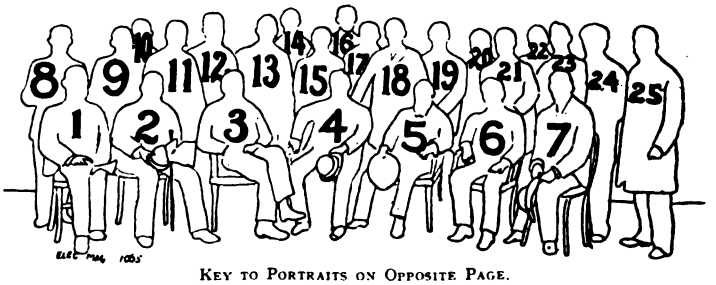
The chamber of delegates considers that these and similar questions could best be dealt with by an international commission representing the governments concerned. Such a commission might in the first instance be appointed by those countries in which legislation on electric units has been adopted, and consist of, say, two members from each country. Provision should be made for securing the adhesion of other countries prepared to adopt the conclusions of the commission. The chamber of delegates approves such a plan and requests its members to bring this report before their respective governments. It is hoped that if the recommendation of the chamber of delegates be adopted by the governments represented, the commission may eventually become a permanent one. That the delegates report the resolution of the chamber as to electrical units to their respective governments, and that they be invited to communicate with Dr. S. W. Stratton (Bureau of Standards, Washington, D.C.) and Dr. R. T. Glazebrook (National Physical Laboratory, Bushy House, Richmond, Surrey, England) as to the results of their report, or as to other questions arising out of the resolution.

Standardisation of Electrical Apparatus and Machinery.

The committee of the chamber of delegates on the standardisation of machinery begs to report as follows :

That steps should be taken to secure the co-operation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardisation of the nomenclature and rating of electrical apparatus and machinery. If the above recommendation meets the approval of the chamber of delegates, it is suggested by your committee that much of the work could be accomplished by correspondence in the first instance, and by the appointment of a general secretary to preserve the records and crystalise the points of disagreement, if any, which may arise between the methods in vogue in the different countries interested. It is hoped that if the recommendation of the chamber of delegates be adopted, the commission may eventually become a permanent one.

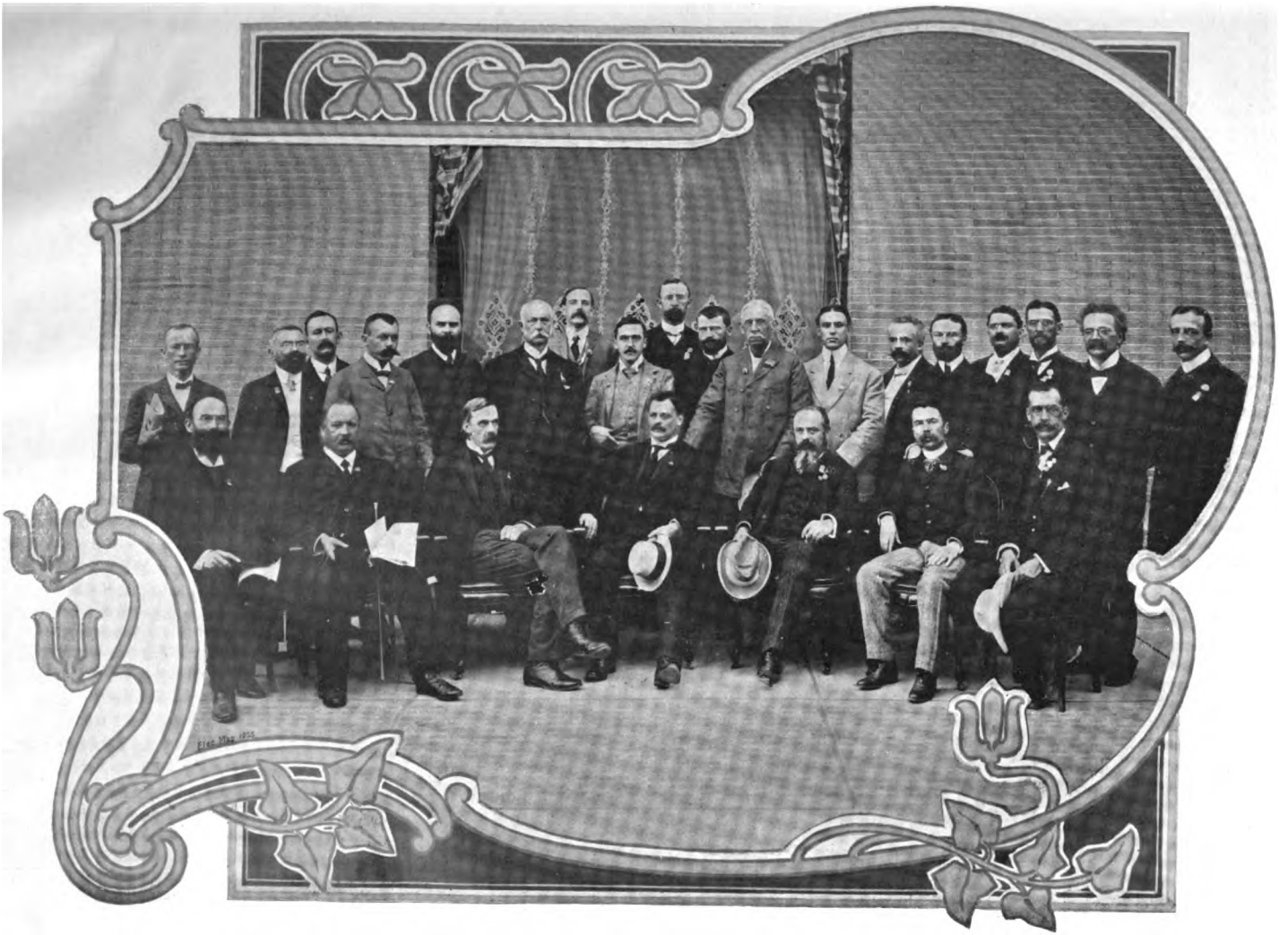
That the delegates report the resolution of the chamber as to international standardisation to their respective technical societies, with the request that the societies take such action as may seem best to give effect to the resolution, and that the delegates be requested to communicate the result of such action to Colonel R. E. B. Crompton, Thriplands, Kensington Court, London, and to the President of the American Institute of Electrical Engineers, New York City.



KEY TO PORTRAITS ON OPPOSITE PAGE.

1. W. Litzendt, Germany ; 2. Prof. Dr. S. Arrhenius, Denmark and Sweden ; 3. Dr. R. T. Glazebrook, Great Britain ; 4. Prof. Elihu Thomson, United States, president ; 5. Prof. M. Ascoli, Italy ; 6. M. Z. de Nerville, France ; 7. A. Gonzales y Echarte, Spain ; 8. Prof. H. J. Ryan, United States ; 9. A. Maffezzini, Italy ; 10. Dr. F. A. Wolff, junr., assistant secretary ; 11. B. Gati, Hungary ; 12. M. Dennery, France ; 13. O. Higman, Canada ; 14. Dr. A. E. Kennelly, United States, secretary ; 15. M. Otamendi, Spain ; 16. John Hesketh, Australia ; 17. Capt. Ferrie, France ; 18. Col. R. E. B. Crompton, C.B., Great Britain ; 19. Prof. J. Newbery, Argentine Republic ; 20. Prof. L. Lombardi, Italy ; 21. L. Solari, Italy ; 22. Dr. S. W. Stratton, United States ; 23. Prof. H. S. Carhart, United States ; 24. Prof. John Perry, Great Britain ; 25. J. C. Shields, India

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International Electrical Congress, St. Louis, 1904. Chamber of Delegates.

(*See* Key on opposite page.)

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IMPRESSIONS OF EMINENT ENGLISH ELECTRICAL ENGINEERS.

(Written specially for "The Electrical Magazine.")

Congress Delegates.

Lieut.-Col. R. E. B. Crompton, C.B.

I NOT only completed the tour in America in the special train, attended the Congresses of St. Louis in double capacity as one of the Government delegates and as a delegate of the Institution of Electrical Engineers, but after the tour was completed I in addition visited a good many works at which electrical manufacture was being carried on, and to which access was in all cases freely given. I think I succeeded in noticing a good many points of interest to English electrical engineers. The ones which most prominently suggest themselves to me is how very slightly the American electrical engineer is differentiated from the English one. In all my conversations with all classes from Elihu Thomson downwards, I found the same feeling of brotherhood in ideas, that our differences in practice, wherever they did exist, could always be explained by local requirements.

I did not find that our American friends were ahead of us in any marked degree, as many English journals, technical as well as non-technical, would lead the English public to suppose. On the contrary, I found that although no doubt America could show a very large number of large installations and consequently there is a considerably larger field for the employment of engineering talent on that side than there is over here, as regards general engineering ability, managing and organising power, I think our English engineers were in all respects the equals of the Americans; in fact, in some respects, notably in the question of economies in the working of electrical supply systems, the severe competition by gas which prevails in this country has rendered our English central-station engineers rather more efficient in these respects than the Americans.

Next, as to manufacture. The Americans, of course, manufacture on a much larger scale than we do in this country. Their home market is of itself many times larger, but I do not think the individual organisation or laying out of the electrical factories or of similar factories where mechanical engineering of approximately the same class is being carried on, is notably if at all superior to the same class of factories in this country; in fact, I think the proportion of up-to-date factories here is as great as it is in America, and conversely the proportion of out-of-date old-time shops that still exist is as great in America as here. In fact, not a few of the shops that I had an opportunity of visiting would, if reported on by the English technical Press be said to be awful examples of old-time practice.

There is one point, however, on which I think all who took part in the tour are agreed, and that is the immense superiority of the American telephone system in all their towns, to anything we have in England. The telephone in America was a delight and a luxury which one feels all the more as soon as one returns to the miseries of the London system.

Dr. R. T. Glazebrook.

The two facts in our American visit which impressed me most forcibly, were the cordiality and hospitality of our reception, and the extent to which our American hosts had utilised science in its application to trade and industry.

At each place we came to it was the same. The various committees vied with each other in making things easy and pleasant, and no trouble appeared to be too great if it was to result in something which would interest the visitors.

And how much there was of interest! From the moment we landed at Boston till the hour of leaving New York, we were continually being shown new marvels. Few of us, I think, had realised till

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BRITISH DELEGATES TO THE INTERNATIONAL ELECTRICAL CONGRESS.

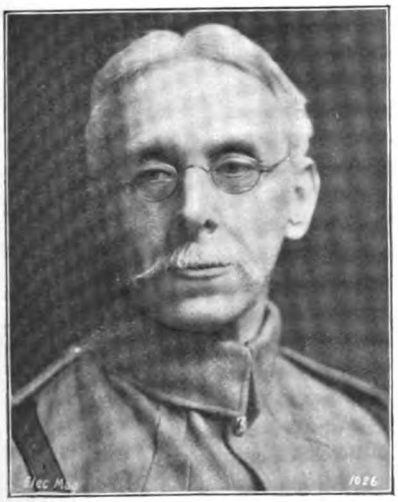
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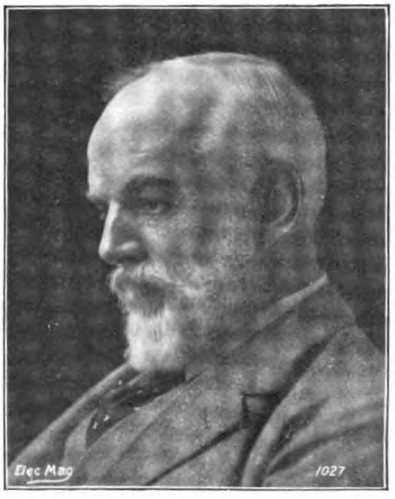
PROF. JOHN PERRY



Dr R.T. GLAZEBROOK.



LIEUT. COL. CROMPTON.



R. KAYE GRAY.

1904.



H.E. HARRISON.



W. DUDDELL. SECRETARY.

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we stood in the Power House, how vast was the work which the New York and Hudson River Railway had undertaken in arranging to run its trains into New York, or till we reached Chicago what was meant by the attempt to supply from a single centre nearly all the electricity used in that city. And how when we reached St. Louis though the Electrical Congress did not arrive at any resolutions productive of immediate and startling change, two discussions of great importance were taken which may have far-reaching results. We hope that the Governments of the great Powers may adopt the suggestion to establish an International Conference of Experts to deal with all questions affecting fundamental units, and we trust that by the co-operation of our own Standards Committee and the Technical Societies of other nations, steps may be taken to standardise electrical machinery in certain features common to designs all over the world.

If these two steps are taken the St. Louis Congress will have achieved a remarkable result, and apart from this, its promoters are to be congratulated on the admirable collection of papers they got together, and the great interest attached to the meeting of so many colleagues in a common work.

H. E. Harrison, B.Sc.

To those of us who had heard of Dr. Walmsley's exhaustive paper on "Transatlantic Engineering Schools and Engineering," illustrated as it was by a very complete set of lantern slides, the technological schools we saw during our hurried tour seemed quite familiar.

It was possible to add little or nothing to the mass of material it had taken Dr. Walmsley three months to collect and arrange; but there yet remained the charm of meeting some, at least, of the *personnel* of these great institutions—the professors and the students.

The older generation of professors, whose names are as well-known and esteemed on this side of the Atlantic as in America, are singularly like our own: they are scholars who love learning for learning's sake, and the success with which they have applied their academic achievements to the advancement of our industry is common knowledge.

The younger professors, on the contrary, have themselves been technically educated, and in them the influence of modern methods may be seen. Now, the essence of technical education is that it shall be of use. The meaning of "use" in its technical sense is £ *s. d.* in this country, and $ in America. Unfortunately, this prevailing idea of "usefulness" is to be traced in much of the original work now being done in these institutions. For research that lives is not the research by which a man lives. Thus it would seem that, while dollars have created institutions which an Englishman contemplates partly with feelings of envy, partly with a sense of shame at the backwardness of his own country, the cult of the dollar may hinder these same institutions from adding to that abstract knowledge which is of advantage to the world at large, but not of pecuniary advantage to its maker.

In this country technical education is only beginning, and we shall do well to study closely its effects in America, so as to see what to avoid as well as what to copy.

Of present pupils I met but few; I did meet, however, a fair number of former students now holding important positions in the various works we visited. And in them, too, is to be found the effect of this training in a marked degree. These men have a very thorough knowledge of the work of their department. They know all about what has been done in the past, and they have distinct ideas as to the direction in which improvements are to be sought. Yet, ask such a man for some very elementary information about what is going on in the department next door, and you find he has never had the curiosity to find out anything about it. The knowledge in question would be of no immediate value to him, so he takes no interest in it. Indeed, he seems carefully to avoid the acquisition of a non-paying fact, lest it should crowd out a paying one.

I have been asked to give some of my impressions, and not too many of them, in a limited number of words. I have given certain impressions, gathered on a hurried trip, the first I have ever made

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to America, which a longer stay might entirely eradicate. I therefore give these impressions, for what they are worth, with all reserve.

Whilst I may alter my opinion about some of the influences of American technical education, the impressions left on my mind by American hospitality are much too deep ever to be materially lessened. It appealed to us, not so much in the form of the receptions and banquets, for these we have in this country, but in the anticipation of every want the English guest could have. I will not endeavour to express the gratitude I shall ever feel for the considerate kindness that was shown to me, even to the smallest details, from the day I landed in Boston until the day I left New York; but I do sincerely hope that our late hosts will soon become our guests, and so let us give some practical proof of our sincere appreciation of their never failing kindness to us while we were with them.

Robert Hammond.

As my visit to the United States was by no means the first one that I had



undertaken, my "impressions" were not so vivid as those of the party to whom the trip was an entire novelty, but, notwithstanding this, I was greatly struck by the magnificent scale on which their electrical undertakings are being worked, and particularly so with the Niagara Works. On the occasion of my last visit one section of 50,000 kilowatts was completed, and the other section was in the "excavation" stage. On this visit the whole 100,000 was a going concern.

Often as I have been to the States I never experienced such abundant hospitality as on the present occasion. I am sure that the trip to St. Louis will prove a livelong memory of the pleasantest nature to every member of the party.

F. H. Nalder.

In putting in black and white the impressions received from my visit with the Institution of Electrical Engineers to the United States, I have somewhat the advantage of other people, inasmuch as I have visited the country a number of times, and have many friends there. But each successive visit impresses on me more strongly every time I go the marvellous activity in all matters which prevail in that country.



Speaking of the electrical industry, as one in which I am more especially interested, the limit of its development still seems boundless. Supply and power stations, with which I first made acquaintance, have grown enormously. The old plants have been weeded out, and in some cases two or three generations of new machinery have succeeded them, each much larger than the preceding. This is most notable in the big cities like New York, Chicago, Boston and Philadelphia, in each of which the progress is almost incredible.

In the early days of the electric lighting and power industry, plants were put in

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and made to run. These were pulled out and others of more developed character were installed. Then, lastly, the magnificent power plants which interested so many of the visiting electrical engineers have been put in recently, with every refinement both as to machinery and buildings; knowing the preceding facts one cannot but be astonished at the enormous capacity to earn money which such conditions must necessarily imply.

Another era is now being initiated. The big railroads are interesting themselves in applying electric traction in the immediate vicinity of large cities. This has been merely talked about over here, but the New York Central Railroad have now in hand the works necessary for electrically propelling the whole of their vast traffic, immediately in the neighbourhood of New York City and for forty miles out.

At the same time one must not lose heart. Many things which are so well done over there are equally well done here at far less cost. If only some organising genius could take in hand the unification under one management of all the varied electric lighting and power interests in London as well as in other big cities, much in the same way as these matters have been unified in New York and Chicago, then great economies must needs result, thereby benefiting the commonwealth.

Of the Louisiana Purchase Exposition what little one saw of it was interesting, but the opportunities which presented themselves to the members of studying this Exhibition very seriously were not many. It is difficult to convey an idea to those who have not been there what an extended area it covered, both as to space and variety.

Of one thing there cannot be the slightest doubt, and that is the boundless hospitality of our American friends, and the painstaking thoroughness of their efforts to make every one feel they were welcome and at home.

Prof. J. D. Cormack.

It was a great pleasure to go so far abroad, and to find myself so much at home. The pleasant days we spent on the voyage out with Americans whose acquaintance was made on board, the good wishes they expressed for the pleasure and profit of our journey, and the many kindnesses they showed when we landed were but the prelude to the great welcome we received everywhere, and the hospitality that was showered upon us. No impression of my visit will be more lasting than that produced by the admirable organisation and conduct of the tour, the extreme cordiality of our hosts, their anxiety to make us comfortable, to show us all that could be seen in the time at our disposal, and to tell us all we wished to know.

It is a great country, and what it has already attained is but the foretaste of the future. The resources and possibilities are almost unlimited, and for their development there is abundant energy and ability.



The conditions obtaining here are so different to those in America, that, although we might improve ourselves by imitating their methods, I feel sure that we must devise our own methods to retain our industrial position.

E. Kilburn Scott.

The time spent in the States and Canada was so full of incident that it is impossible to do justice to one's impressions in a few paragraphs. Perhaps the features of American life which impressed me most were the accessibility, the optimistic youthfulness, and the disregard for precedent of the business men.

It happened that I had some little business to transact, and I was specially struck with the way in which it is possible to get right to the fountain-head. Instead of having to run the gauntlet of a commissionaire and several officious junior clerks, one is welcomed with a glad hand. Indeed some of the larger concerns have a special "glad hand" member of

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the staff, whose duty it is to receive visitors and facilitate business. I mention this particularly as some of my American friends made serious complaints of the cold and officious way in which they had been received in London.

Regarding the youthfulness of the men holding leading positions this is most remarkable, and is not confined to electrical engineering, as sometimes stated. The average age of the best engineers and managers—the men who are really doing the work—is nearer thirty than forty, and judging by results I think the sooner elderly engineers and managers of this country retire and let younger men take their responsibilities the better. It is disgraceful to see the way in which our out-of-date old stagers keep money-grubbing and mooning along. Those who have the gift of the gab should get themselves made county councillors or help to lower the percentage of lawyers in Parliament. They would find plenty to do in helping to revise our laws as they affect engineering enterprise.

Disregard for precedent is another way of saying that the American business man has no use for preconceived ideas. If shown anything which appears to be better than existing methods he rushes for it; whereas in England an improvement or a new machine, for example, has to be almost given away to get it introduced. The odd thing is that the men who are most enterprising in the States are generally British born: take for example Carnegie and his lieutenants. It seems as if there is something in the atmosphere which makes men more wideawake, optimistic, progressive, and appreciative of brains. The cosmopolitan character of the population has also something to do with the rapid industrial development. One would expect that the building of such an essentially American product as the skyscraper would be entirely in the hands of real Americans. Yet the manager who took me over the New Trinity Building in New York was a Highland Scotchman who did not go to the States until he was eighteen years of age. He has superintended the building of four skyscrapers in three years, including the famous "Flat Iron."

One of the principal citizens in St. Louis is a "mon fra Sheffield," who, although he has been in the States forty-two years, has not taken out naturalisation papers. He remembers when Jessops of Sheffield did 90 per cent. of the high-grade steel trade in St. Louis and district, now they do not get 10 per cent. To thousands of Britishers America has spelt "opportunity." I saw no justification for a halo on the American engineer. He is just a plain man who keeps his eye well on the main chance and makes good use of his opportunities of which he has plenty and to spare.

I have written at considerable length elsewhere on the engineering features seen on the trip, but I may remark that the speed with which the Curtis steam-turbine has been developed and placed in effective commission is most striking. Besides reflecting great credit on the makers it says much for the pluck of the officials of the Edison companies in adopting on such a large scale a prime mover entirely new and entirely different from any they had previously used. One could not help feeling that those magnificent modern stations in New York and elsewhere which had slow-running engines with cylinders in quadrature were already hopelessly out of date. Two years ago no one would have thought the steam-turbine was destined so soon to oust the steam-engine in power-station work; and yet it has done so, and we are even now on the doorstep, as it were, of the gas-turbine, for this is undoubtedly the next move. Even the General Electric Company are amongst those who think it worth while to spend money on experiments with gas-turbines. Sir Frederick Bramwell's prophecy about the steam-engine and museum is likely to be antedated.

Until recently very few engineers in the States had a good word to say for alternate-current traction; but now, at the bidding of the two great firms, everybody is "falling down to worship

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the single-phase traction motors which they have set up." The hateful trust movement seems to have touched electrical engineering—at any rate, there is a suspicious unanimity amongst American engineers which does not seem quite natural. Not so many months ago the mascot of railway traction was 600 volts direct-current, with mongrel rotaries and death-dealing third rails. And with the help of much bluff and some Wall Street finance, this system has been dumped on to us. It is to be hoped that British engineers, and particularly the railway people on this side and in the Colonies, will in future think things out for themselves and not swallow the new single-phase system as the ideal simply because it has been developed in America. They should be specially chary of employing men as experts who have been previously identified with American work.

Taking the North American Continent as a whole, its immense resources and rapidly increasing population are bound in time to make it the industrial centre of the world. Any one seeing the Pittsburg Steel Works, for example, cannot help acknowledging that, tariff or no tariff, it was bound sooner or later to be a great steel and machinery producing centre. Indeed, the wonder to me is, that this little island has been able to keep its end up, industrially speaking, for so long. With increased facilities of transportation, the natural tendency of the future will be to manufacture goods near the centres where the raw material is found or grown; and what has happened in the States will some day happen in the Colonies, &c. The rail renewals in India, for example, are already enough to keep a steel works in full blast; so why should steel not be made there, seeing they have some of the finest iron and manganese deposits in the world and a coal good enough to export to Ceylon and the Straits Settlements? Independently of everything else, however, the country with abundant water power, especially with high-head falls, such as in California, is going to be at a great advantage in the near future. The power which is already harnessed in the States and Canada is already very large, and in a few years more, Niagara alone will be delivering 500,000, electrical horse-power.

I am old enough to remember the decline of the flax-spinning industry in Leeds, and the consternation with which the news was received some twenty-five years ago that Marshalls of Holbeck (whose mills were at one time the largest in the world) were removing to America. I can see now how wise they were, for to remain in Leeds meant ruination, whereas going to the States spelt continued prosperity, and incidentally I find that the American nation benefited by the gift from Marshalls of one of the finest private hospitals in existence.

Whether we like it or not, it is the Britisher's destiny to go to other lands (preferably the Colonies) and do industrially what our forefathers did for this country. There is no getting away from the fact that, industrially as well as agriculturally, these little islands are being left behind. There will always be a certain amount of industrial work of course, but the future of the country will be more and more that of a banking and shipping centre, and for all time the homeland of the Anglo-Saxon race. The sooner the absurd parochial talking-shop at Westminster gives place to a real Imperial Parliament modelled on the lines of the one of Washington the better. It would be as easy for representatives from Canada and South Africa to come to London as it is for the Californian representatives to attend to their Parliamentary duties at Washington.

Personally, the greatest joy of my visit was the glimpse I had of Canadian life. To go to a splendid city like Montreal, with its 75 per cent. French Canadian population, loyal to a man, and seeing eye to eye with ourselves, was a lesson not to be forgotten. Canada is indeed a jewel of the Empire, and independently of its vast agricultural lands in the West, is destined to take a leading position in industrial enterprise. Its contiguity to the States is all in its favour, as the tendency is for capital and the best of the white population to flow northwards. The race question in the Southern States and the possibilities of violent labour disputes are helping this movement.

Of all the various places I visited I think I liked best a little Canadian town of only 42,000 people. It is in the county of Middlesex, on the River Thames, and

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is called London. It was quaint to walk down Oxford and Regent Streets and see other reminders of our village in the Old Country. London, Ontario, was the only place where I saw the people go about their business sedately; they do so on the principle that there is something more in life than merely chasing dollars.

In conclusion I would say that nothing could exceed the kindness and hospitality of our hosts. Personally, I made many friends, the pleasant memory of whom will remain for many a long day.

Dr. D. K. Morris.

I am sure that, in common with every one in the party, I was surprised and delighted at the enthusiastic nature and the openness of our reception. One of my impressions was that the directions in which American electrical engineering work is in advance of that which has been developed here are in nearly every case those arising from the greater scale of their work; great distance and quantity of power transmission; larger traction problems, &c. Both the disadvantages and advantages of great industrial organisations such as the General Electric and the Westinghouse Companies were apparent. The disadvantages appear to include the retaining of well-tried but partially obsolete methods; of which, perhaps, the persistence of two-phase plant in certain types of installation may be quoted as an example. But the advantages were very apparent, as, indeed, they are on the Continent also. Of the many which occur to one possibly the most real is the enormous resources which can be steadily directed towards the development of great new problems; the perfection of the steam-turbine; the improvement of single-phase traction methods; the working at the highest voltage-limits in power transmission. Such work is also well supported by more theoretical work in the technical universities and colleges, and everywhere is appreciated the value of the man who can apply theory and intelligently deal with the technical problems which arise in the search for improvement.

C. D. Taite.

As a station engineer I was particularly struck with the substantial manner in which American electrical engineers are building and equipping their power stations. In some departments of engineering we have frequently been told that it is not the practice in America to provide such substantial work as is usually the case in this country, on the grounds that if too well built such machinery might outlast their economic life; modern American power stations, however, do not seem to be built with any thought of the scrap heap for the next fifty years; certainly no work in this country is being carried out on sounder or more complete lines.

The same remarks cannot be applied to the American methods of finance, which have so overloaded their undertakings with capital that although the average price charged for electrical energy is very much higher than in this country, and the cost of production is no greater, yet the dividends are hardly to be compared with those paid by the leading London Companies.



In the matter of supply pressures, this country is—in my opinion—distinctly ahead of the American cities; but as regards preparedness to meet competition by adopting systems of free lamps, special rates, &c., we can learn some useful lessons from the other side.

F. M. Long.

I have pleasure in giving you a few out of many impressions that I received during the Electrical Engineers' tour in America. I was particularly struck with the way the American engineers adapt themselves to the problems they have to deal with. In designing new work the ultimate object is clearly kept in view,

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and no preconceived ideas or prejudices are allowed to stand in the way. If a project is temporary in its nature, then nothing more than is absolutely essential is put into it. The work is not badly done, it is by no means "cheap and nasty," but being only intended for a limited period only materials sufficiently good to last such time are used.

In this way many hundreds of miles of light railway, or I should say railroad, have been constructed and new works exploited, works which could not have been possibly made to pay if heavy capital expenditure had been incurred.

Here we are brought up to think that work cannot be done too well; but I think that this idea is often allowed to have too much weight, and a great deal of unnecessary cost is incurred, and this acts as a hindrance to progress. There was no lack of evidence in the States that where work is intended to be permanent they know how to construct it in a thoroughly sound and substantial manner.

Another point that struck me was the pains taken to supply a good article, or I should perhaps say something adapted to requirements. This was shown in the time and money spent in making experiments and testing new apparatus, and also in electric lighting, in their system of supplying lamps free, and readiness to exchange old lamps at any time in order to ensure that consumers may always have a good light, which is the thing wanted, rather than electrical energy.

As regards the tour, one can have no feelings but those of praise for the excellent way in which the arrangements were made and carried out, and of gratitude to our kind hosts for the lavish way in which they entertained us, and attended to our comfort and enjoyment.

P. S. Sheardown.

One was naturally anxious to see how closely America and the Americans coincided with the ideas we in England had concerning them, and, on the whole, I think the general impressions were true, but somewhat exaggerated. Americans are bustling and energetic, but it is not apparent to the extent that one expected, and I think that the reason they get through so much work is due quite as much to good organisation as it is to long hours of work. We have all heard that in America, Jack is as good as his Master, but it rather impressed itself on one that this ideal did not work very satisfactorily, Jack seemed very much afraid of damaging the theory by showing too much civility, seemed in fact unable to discriminate between civility and servility, which are two different things. The presence of the former certainly tends to make everyday life run more pleasantly. One great advantage the Americans have over us is in the matter of soberness. From all I could learn, as well as from observation, practically all classes in America are most temperate with regard to drinking intoxicating liquors; and I believe this fact gives them a very great advantage over us in manufacturing and commercial progress.



With regard to engineering matters, the modern American power station impressed one very forcibly, everything from the general lay out to the smallest detail appeared to have been fully considered; solid construction and accessibility being the leading features; but the power stations, especially in New York, were practically duplicates of one another with regard to design.

The steam-turbine was very much in evidence, and the makers of same evidently intend to depose the reciprocating engine at all events in large sizes, and probably will, for the "follow my leader" fashion is much in evidence in the present day; but to get the economy talked about, condensers and the working of same will have to be much improved. In one large turbine station I noticed but 26 ins. of vacuum, although 28 ins. is the figure generally mentioned in papers on the subject, and it must be remembered that difference in steam consumption is 5 per cent. per inch of vacuum.

It is difficult to understand why fuel

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economisers are so little employed in the States. In the later stations they are practically never to be found, and in the ones under construction there is usually provision made for installation at some future time, as if there was still some doubt as to whether their installation paid. The feed water is usually heated by the exhaust steam from the auxiliaries to about 120 degrees F., at which temperature the boilers are fed. With an economiser kept clean 250 degrees F. can easily be obtained and I think English practice in this respect is sound, and will soon be followed on the other side.

Although the economy gained by fuel economisers seems to be ignored, American station engineers appear to be much impressed by the economy in operation which can be effected by the installation of storage batteries, as in nearly all the large rotary converter sub-stations, storage batteries are to be found.

Manufacturing concerns appear to be loudly proclaiming the virtues of the single-phase railway motor, and there would appear much to be said in its favour in its present improved form under certain conditions, but I think it will have an uphill fight with the direct-current motor in the States, as America seems much wedded to three-phase alternating-current transmission transformed to direct current for operation, and it is significant that after full consideration the big electrical operation schemes of the New York Central and Hudson River Railway Company, and also of the Pennsylvania and Long Island Railway Company are to be by direct current.

Considering the conditions under which they work the prices charged per unit for electricity by the supply companies appear to many of us very high. The output of the Waterside Station of the New York Edison Company last year was 131,000,000 units with a load factor of over 50 per cent. The price paid for coal in New York appears to be about 13*s.* per ton, and was of good enough quality to evaporate 8.5 lbs. of water per lb. of coal on a twenty-four hours' run, yet the price charged to ordinary consumers in New York was 7½*d.* per unit for the first two hours, the price varying as the average use increased, being 5*d.* for the third and fourth hours of average use. Why it should be so much it is difficult to understand, but probably the capital cost per unit installed is high, the cost of cable laying being, I should think, very heavy; and again it must be remembered that the purchasing value of a five-cent piece in New York is not much more than that of a penny in an average English town, so that compared with other commodities their price for current is comparatively less than ours.

With regard to the early scrapping of old and inefficient plant, I think this is not carried out to the extent we imagine, in looking round the repair shops of one of the largest electric tramway systems, I was surprised to see a number of old type of car motors still kept in service, and noticed the same thing elsewhere. The systematic organisation of work and careful collection of information and data are, I should say, on an average, much more thoroughly gone into with them than is the case with us. I should be loath to close these few notes without mentioning the very great impression made by the kindly, thoughtful and generous way in which we were received everywhere and by every one, and it added not a little to the charm to be able to feel all through the tour that our reception was as much a source of pleasure to our hosts as to ourselves.

H. G. Whiting.

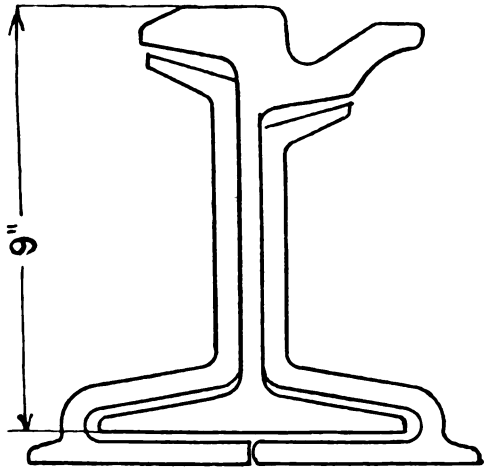
Considering what a great amount of attention and interest which has been given to permanent-way construction for tramway systems all the world over during the past few years, I thought a brief description of the method employed by the Philadelphia Rapid Transit Company would be of interest to your readers. I give it as I believe very few of the English members visiting the States with the Institution of Electrical Engineers this year went to



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see this work being carried on in the streets during our short time in Philadelphia, and I know very well how surprised most of our party were at the condition of the permanent way of most cities we visited.

There are one or two points which are quite unique in this permanent way construction. In the first place, the rail which has been adopted is heavier than any used in Great Britain—the depth being nine inches, and weight 137 lbs. per yard (Fig. 1). Secondly, the joint is quite uncommon and very interesting, being a kind of compromise between the ordinary bolted fish-plate and the welded joint, and is different to any other I have seen. A description of same is given further on. When laying the rails, trenches are cut about eighteen inches wide and twenty-two inches deep along the road; and the space between cleared to a depth of six or seven inches. Temporary ties made of channel iron are then placed across the trenches about ten feet apart, with the channel turned down to ground. These have bolt holes at each end to clamp the rails to the holes, being placed at such a distance apart that when the rails are clamped on to them they are practically set to their proper gauge. When the channel-irons have been put down, the rails—after having their ends thoroughly cleaned by a portable sand-blast machine—are laid on top and



Elec.Mag. FIG. 1 996

adjusted in line along the track ready for the joints to be made. The specially rolled plates which help to form the joint are then riveted on to the web of the rails, leaving a space of about five-sixteenths of an inch all round the base of rail, also spaces between the underneath side of head and groove of rail and the flanges of plates (*see* Fig. 1). When this has been done, a composition of molten zinc is poured into the spaces, filling up absolutely tight any irregularities or unevenness of the rails and plates and practically galvanising the two together. The zinc composition also takes the place of the usual bond, no other electrical connection being made.

The rails are now moved out towards the ends of the ties and clamped on to same by clips as mentioned before. The cast-iron chairs which are used on this construction are now clamped to the base of rails at every five feet, being thus suspended over the trenches. These chairs have two sets of bolts and nuts, with clamps on them for eventually fastening the rails down securely and in line (*see* Fig. 2). At equal distances between the chairs round iron tie-bars, with the ends bent down into the trenches under the rails, are now slung lightly from the rails for the purpose of binding the concrete foundations to each other and preventing spreading of rails. These tie-bars are not finally fastened to rails at all, as generally done, but are simply to hold the stringers of concrete together.

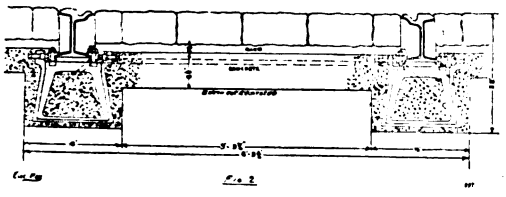
The rails are now levelled up and adjusted true by packing up the channel-ties on which the rails are resting, and then the trenches are filled in with coarse concrete to within one and a half inches from base of rails; this space being afterwards filled in with fine concrete well tamped under the rail.

When the concrete is set, all the channel girder-ties are removed and the final adjustment given to the rails by the bolts and clamps on the cast-iron chairs being well tightened-up—thus securing the rails firmly to the foundation.

A sheet of concrete about six inches deep is now filled in between the rails to make a firm foundation for the paving, which is put down in the usual way with sand-base and cement grouting.

The novel method of joint-making

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seems to be giving satisfactory results, judging from some which had been down for about two years, and which the Philadelphia Transit Company's engineer told me showed no signs of giving way. Further results will therefore be watched with great interest. I trust that with the diagrams given, the above brief description will make everything clear. I would like to mention here that although the permanent-way construction work, car-sheds, repair-shop, &c., of the Rapid Transit Company were not down on the official programme for our visit to Philadelphia, through the kindness and courtesy of one of their engineers two of us who went to the above were shown over every place we wished to see, and no time or trouble was spared to give us all the information possible; indeed, it was only another example of the same untiring energy and hospitality which we met with everywhere on our visit to the States, and which will be long remembered by everyone who went with the Institute party last year.

W. H. Scott.

The thing that struck me most in America, was what might be called the happy discontent of the people. This was manifested in the constant readiness for change and improvement. It was more than a readiness. Progress was expected and looked for in every direction.

The thing that I think shows this state of mind in a very remarkable degree is the change that has come over the habits of the men there with regard to the very objectionable habit of spitting. I understand that as little as five years ago this was prevalent to the degree that we on this side have generally been led to understand it was in America, but we on our visit saw no more of it than we should in England. We only saw the relics of the habit in the disused spittoon.

The nation that can change a habit like this in five years can do many other things on the same lines when the need becomes sufficiently crying; and it is for this reason that I look upon the evils connected with trusts and municipal corruption there as evils that will not be allowed to continue so as to become really serious factors in the prosperity of the nation, or in the happiness of its people, and of course it goes without saying that the attitude of mind must make them specially ready for all kinds of improvements in engineering matters; and my wonder now is, not that so many new ideas in engineering are developed in America, but rather that so many are developed on this side of the Atlantic. A man with something new here is looked upon as a good deal of a nuisance, as upsetting things that are going along very well; and he undoubtedly has a much easier time in America.

W. A. Barnes.

It is a well-known fact that the members of the electrical profession are a most sociable body of men; and the good fellowship which exists between them, of whatever nationality they may be, was amply proved during the visit to our American friends in September last. The lavish hospitality extended to us, the manner in which everything that was worth seeing, and might be of interest, was thrown open to us, and the welcome which we received at every town we visited, will, I think, leave a deep and lasting impression on the minds of all who took part in the trip. Apart from the purely technical side of the visit, the way in which the party was transported from town to town, from the arrival at Boston to the departure from New York, with 3,000 miles between, was an object-lesson in organisation, especially so when one remembers that the party numbered upwards of 250, and the pilgrimage was conducted without mishap from start to finish.

Coming to the technical side of the trip, a most suggestive point was the almost universal adoption of the steam-turbine in the large central stations, for the extensions contemplated or in progress. This was particularly noticeable in New York and Boston, and again at the

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Westinghouse Machine Works, Pittsburg, where the manufacture of the large reciprocating engine was conspicuous by its absence, whilst a large number of steam-turbines running up to 8,000 h.p., were in course of construction. It seems strange that the Americans still keep to the low-voltage incandescent lamp, one of the things where they seem to be behind the times. Another point of great interest was the great pioneer work which they have done and are doing with the single-phase traction motor, a field which is comparatively new over there, and which is almost unknown except by name in this country. I should like to express here my great appreciation of the many kindnesses that were accorded us during our all too brief stay with our friends across the water.

A. P. Pyne.

It did not appear to me that our American cousins were so far ahead of us in electrical matters as one generally supposes when the physical conditions prevailing in the two countries are taken into consideration. My general impression, therefore, was one of disappointment, hardly dissipated by the excellent organisation and magnificent hospitality of our hosts.

I was agreeably surprised by the comfort of railway travelling, though time keeping was not above reproach. We might also learn a lesson from the rapidity and convenience of transit afforded by the excellent street car services; not only in the large cities, but, in many instances, in straggling townships, where the overhead gear was cheaply and easily erected, and which while quite sufficient for its purpose, would be impossible in this country of stringent Board of Trade regulations.



The employment of electricity on American warships has reached a more advanced stage than with us, in several cases the generating plant being capable of an output double that in corresponding ships of the British navy. I noticed its successful and apparently general application for several purposes, which in our navy are still very much in the experimental stage. The American practice of running the cables in iron conduits is, however, open to grave objection, and may lead to serious trouble in action.

The tour on the whole was very interesting and instructive, affording as it did an opportunity of comparing the methods of the Old and the New Worlds. And I fear that in this limited country we should have considerable difficulty in adequately returning the hospitality so lavishingly bestowed upon us.

L. G. E. Morse.

As to my impressions of America I must first mention the boundless hospitality with which we were entertained and the completeness of the arrangements made for our instruction and entertainment. My chief impression of America — but not of Americans —is the enormous size of everything; an American city is like an English town seen through a magnifying glass: and the result is similar, for everything is coarser and rougher, as is natural in cities which have sprung up so much more quickly. I should imagine that the working and middle-class man cannot afford to get so much pleasure out of life as his English equivalent.



In many ways England appears to be a more democratic country than America; it is surprising that the principle contained in the 5 cent trolley-car fare is not extended in all directions. For instance, the charge of 15 cents (7½*d.*) for a telephone call from one's hotel to a subscriber in the same town hardly encourages its

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use. We did not seem to see as much "hustling" as we had heard about, but the reason may have been that we were being "hustled" so ourselves that we did not appreciate it in others. Counting from London, we travelled about ten thousand miles in five and a half weeks, which was quick enough for any one.

A. F. T. Atchison.

During the recent American tour of the Institution of Electrical Engineers the members were shown so many things and had such a variety of experiences that to give "in a few lines" even a brief summary of the impressions gained of American engineering methods is not an easy task. The subject indeed has already been treated at greater length by more than one of those who took part in the Institution visit.



What are the chief points which strike one most? Perhaps in the foremost place must be put the large scale on which most of the engineering enterprises are carried out. If we except a few of our most recent electrical undertakings in this country, the figures quoted in American statistics seem to have an additional nought added. Also we cannot help being struck by the way in which recent improvements are adopted in many instances, and out-of-date apparatus abandoned. The value of a scientific training for engineers is properly appreciated, and various problems, which, it is to be feared, are sceptically regarded in this country as theoretical fads, are dealt with on their merits, often with most successful results. Scientific engineers ready to undertake schemes of great boldness, backed up by men of great business ability, have advanced engineering in general to a remarkable extent. Lack of space forbids discussion of detail, but broadly speaking it appears to be in electric traction and telephone work that the greatest advances have been made, and in power transmission the natural resources of the country have given opportunities for undertakings of very great magnitude.

No word of the impressions gained on the visit of the I.E.E. to America would be complete which did not bear testimony to, and show appreciation of, the extreme cordiality and lavish hospitality which our American hosts extended towards their visitors on all the many occasions on which they came in contact throughout the tour.

S. E. Fedden.

Mr. S. E. Fedden, who accompanied the Institution of Civil Engineers to America and is the general manager and engineer of the Sheffield Corporation Electric Supply Department, gives us some impressions of America from his report specially prepared from the tour and presented to his Electric Light Committee.

"Our own work has made such strides in the last few years that to-day we need fear no comparison with American methods in point of scientific development; and although, in the nature of things, most of our undertakings are on a smaller scale, there is undoubtedly a high average of excellence to be found in English practice, and greater consideration for the comfort and safety of the general public. Much of the work to be seen in the States is obviously designed to meet as cheaply as possible the demands of the moment. It seems to be generally considered improbable that any more very large general exhibitions will be held, their object being much better attained by smaller special expositions.



"The general tendency of modern American practice in power generation and distribution is to concentrate the plant at one or two centres, and reap to the full the advantages of large units, and the highest practical limits of steam pressure, voltage, &c.

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"So far the bulk of traction work has been carried out with direct-current motors on the cars, involving the transformation of the current from high-tension alternating to low-tension direct, but it seems most probable that a commercially successful monophase alternating current motor for tram and railway work will be on the general market very shortly.

Already the Schenectady Railway has a car fitted with a single-phase series commutator motor, which will work equally well with direct or alternating current, owing to an ingenious arrangement of compensating windings, so that the train can be immediately applied to a high-tension alternating line or an ordinary direct current low-tension supply. The progress of this arrangement will be watched by engineers with great interest, as likely to assist in the solution of the "transportation problem," by enabling the short-distance traffic to be dealt with by means of light rolling-stock, easily adaptable to the varying demands, and to convey passengers from the interior of one centre of population to another, without changing, and its attendant delays and inconvenience, where the distances are not too great. This will at the same time pave the way to the gradual change-over of the main-line traffic to electric driving, as the present steam locomotives become old and obsolete."

A SWEDISH OPINION.

J. S. Edström.

THE Americans were always pioneers in the development of the tramway. Through their ingenuity and enterprise the modern tramway system was brought to its present standard form and installed in most American cities. These systems proved, as a rule, successful economically. This was not always the case, however, when the tramway systems were extended between two or more neighbouring cities. Owing to the low pressure used in the operating overhead wire (500 or 600 volt direct-current), the tramway system proved too expensive to be economical when running through the sparsely populated country districts. The high-pressure alternating-current transmission with rotary transformers was also too expensive to be used.



American ingenuity, however, again was successful. Our European party—some of us at least—had the pleasure to ride between Schenectady, N.Y., and Ballston, N.Y., on a car supplied with four-series motors, which, within the city of Schenectady, were operated on the 500-volt direct-current overhead wire, while outside the city the power was supplied directly to the trolley from a 2,000-volt alternating-current overhead line. Consequently a simple system has been invented applicable to the old tramway installations in the cities, and in the surrounding country operating with an electric current of a pressure which will considerably increase the profit of the undertaking. The time is drawing near when, in America, a net of tramway lines will cover the Eastern and Central parts of the States. Not only the tramways will profit by the new system, however, in order to meet the competition of the tramways, the old steam railways must follow and give their customers the comfort of the electric train. The high-pressure system will also in this case render the undertakings successful economically. At Pittsburg we had occasion to see the details of the work carried on in this line.

Our trip across the ocean surely has given us the chance to peep into the future and let us get an idea of a coming era of great development in the electric tramway world. Not only in the line of tramways and railways did our American hosts show us proofs of American forethought. The rapid and extensive use of the steam-turbine electric generator, the accuracy and simplicity of the automatic telephone, the successful operation of most daring power transmissions, the enormous developments of the Niagara Falls' water-power plants, were all features proving to us that American ingenuity

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and enterprise still are leading in various fields of electricity.

Extending my thanks to our American friends, not only for the chance of seeing all progress and development, but also for the friendly and splendid way in which we were received everywhere, I express my best wishes for continued American success in the electric field.

ELECTRIC TIME-SERVICE IN THE UNITED STATES.

A Comparison of British and American Practice.

By F. HOPE-JONES, A.I.E.E.

It is not until one is on the voyage home that impressions of travel in a far country should be written or even formed. A diary of daily sight-seeing invariably exaggerates the thing of the moment and lacks proportion. One must step back to view the picture as a whole. Abler pens than mine will no doubt review in this spirit the impressions which the members of our Institution of Electrical Engineers have formed of American practice in light, power, and traction: I will confine myself to the comparatively trivial subject of electric time service—a subject which is too small for the big men to deal with or even for mention in the Proceedings of the St. Louis Convention.



To make any comparison instructive it is necessary first to recollect the condition of this little industry at home. It is practically in the hands of three organisations. First, the Telegraph Department of the General Post Office, who receive the standard signal from Greenwich and transmit it over their ordinary wires at a pre-arranged hour once a day to the telegraph offices of provincial cities and the larger towns. The post-office clocks are approximately corrected by hand to accord with these signals, but no automatic or exact synchronisation is attempted. Secondly, the Standard Time Company, Ltd., whose operations are, unfortunately, confined to London, where they have their own network of wires, on which a time-signal, primarily derived from Greenwich, is transmitted every hour to about one thousand subscribers. These impulses are used to ring single-stroke bells, to deflect a needle, or, more frequently, to forcibly correct or synchronise the hands of any ordinary clock belonging to the subscriber. Thirdly, the Synchronome Company, who have installed in some three hundred of our larger factories, offices, and institutions in all parts of England circuits of step-by-step dials electrically propelled in synchronism.

In America, the Western Union Telegraph Company stands for our Government Telegraph Department, and until the Postal Telegraph Company was formed recently the public looked to them alone for the telegraph service throughout the whole of the United States. Such an organisation is of course the most competent body to undertake the distribution of time-signals in a wholesale manner; and it is perhaps largely due to the fact that in the United States of America the telegraphs are in the hands of a company, and not of a Government department, that the system is more generally used for the transmission of time-signals than our own telegraph system at home. A daily time-signal, originating in the Washington Observatory, is transmitted throughout the United States of America; and in many of the more important cities and towns, even in the distant States, it is retransmitted every hour and directly applied to subscribers' clocks, automatically synchronising them.

These clocks are electrically wound and installed and maintained on a rental system by the Self-winding Clock Company of Brooklyn, N.Y. This is the Company whose English patents were exploited here in 1886; but the "Self-winding Clock Company, Ltd., of London," failed in its second year, having no alliance with people competent to synchronise their products. The Company left behind them a few of their motor-driven clocks (which can still occasionally be picked up second-hand), and a firm impression that there is no

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market in this country for clocks which merely " go without being wound up."

The modern pattern of the Brooklyn Company's self-wound clock is a distinct improvement upon that which failed in England. Since its foundation in 1885, this Company has turned out some fifty thousand self-wound clocks, of which about three-fourths are rented and synchronised by the Western Union Telegraph Company, New York alone having some three thousand subscribers at a dollar and a half per month, or £3 12*s.* per annum, served by line-wire of a total length of two hundred miles. A special service for the leading jewellers is also provided, consisting of the retransmission of the complete " Washington Code "—a signal every second except the thirtieth and fifty-fifth to fifty-ninth inclusive, repeated every minute of every hour throughout the day, except that in each fifth minute the five seconds from fiftieth to fifty-fourth inclusive are also left out. There are about one hundred subscribers to this special service in New York at $30 per annum.

It would appear that no such municipal ordinance as that recently laid down by the Court of Common Council of the City of London requiring public clocks to be synchronised is necessary in America. There is without doubt a greater appreciation of accuracy in time-keeping on the part of the general public, and this is not surprising in a nation who are rather proud of their reputation as hustlers. If not the first to suggest, they were at any rate the first to make a practical success of pneumatic driving of larger clock-hands. The great Floral Clock at St. Louis, built by the Johnston Service Company, was a fine piece of pneumatic engineering, controlled by an ordinary regulator clock synchronised by the Western Union Telegraph Company.

In the wholesale distribution of time-signals and the uses to which they are put, we must therefore admit that our American cousins are ahead of us; but we need not attribute this to any want of inventive ability on our part, but rather to the fact that the commercial possibilities of time-signalling are insufficient to attract private enterprise unless that enterprise has already at its disposal, lines, wayleaves, or underground facilities. The Western Union Telegraph Company of America have these facilities, and use them: the Telegraph and Telephone Departments of our General Post Office have them, and don't. The Standard Time Company, Ltd., had no such facilities when they began, yet they have established a good service in London, and are doing more than we have a right to expect or can adequately remunerate.

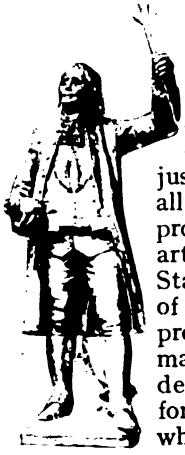
With regard to independent installations of electric clocks, however, the comparison between English and American practice is certainly in our favour. Of the many large industrial establishments which I visited not one was equipped with time-circuits such as we have here. Office buildings occasionally are provided with electrically propelled clocks, but I never once saw a circuit of large dials in the workshops and yards of the great manufacturing concerns; and I was informed that the synchronous electrical propulsion of workmen's time-recorders had never been attempted, though frequently done here.

In Pittsburg there is a block of office buildings, I forget how many stories high, but I cricked my neck in trying to see the top, which was equipped *by the landlord* with a system of four hundred electric clocks. He offered uniform and accurate time as an extra inducement to his tenants, and made a slight addition to the rent, which repaid him handsomely. There is a lesson for both of us here.

The opportunities afforded by the Institution trip for studying such a subject under the auspices of the American Institute of Electrical Engineers were exceptional; and in adding my thanks to them for their hospitality I would like to remind them that they have not yet accorded electrical time service its place as a reputable branch of the electrical engineering profession; yet in no country is there a greater demand for its serious treatment, either by virtue of the immense industrial activity of the nation or of the inborn time-saving propensities of its people.

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POWER-PLANTS AND OBJECTS OF ELECTRICAL INTEREST ON THE CIRCULAR TOUR.



THE route selected and the towns and cities chosen, out of the many of which Americans are justly proud, were, each and all, fully representative of progress in the electrical arts in the Eastern United States. Starting in the home of Franklin and ending appropriately at the high-water mark of America's industrial development, the tour formed an object-lesson of what enterprise and energy can do, and after a manner difficult of repetition in any other country; so rapid has been the advance made.

Throughout, the inspection of power-plants and manufacturing works afforded little if anything fundamentally new. Everywhere impressions were gained of differences of magnitude only between designs and methods familiar enough at home. Factors duly proportionate to the mind in the mother country seemed multiplied several times under American skies, and first anticipations of novelty gave place to prospects of monster forms designs of already intimate in electrical apparatus.

The programme proved varied to a degree beyond the impression given by a glance at its official pages, and none could complain that full opportunity was not given for a scrutiny of the most modern of electrical works in progress in America. With local reception committees formed of the cream of American electrical engineers to cordially welcome us, with luxurious railway trains to transport us, and with the finest examples of electrical works and power-plants open for our unhampered inspection, not even the most fastidious had occasion for other than the highest approval of our hosts' efforts to do us honour.

BOSTON.

ON Saturday, September 3, the chief objects of electrical and general interest in Boston were inspected, automobiles acting as a speedy means of transit. South Boston was first visited as the hub of the city, and suburban electric lighting is there centred in the great L Street station of the Boston-Edison Company. This Corporation has sprung from a modest concern, the Edison Electric Light Company, which, in 1886, operated what was probably the first power-plant of any size in the world, and, in 1887, was supplying some 300 h.p. of motors. To-day the Edison Company has a capital of £1,727,100, some 19,000 consumers and operates over an area of 290 square miles. During its development thirteen companies have been absorbed with about twenty-six steam and water power-plants. The high price of fuel has compelled the concentration of the plant into two large stations, one of 12,000 kw., delivering direct current to the business area, and the other of 10,500 kw., supplying three-phase currents at high voltage to sub-stations outlying the direct-current area.

L Street Station.

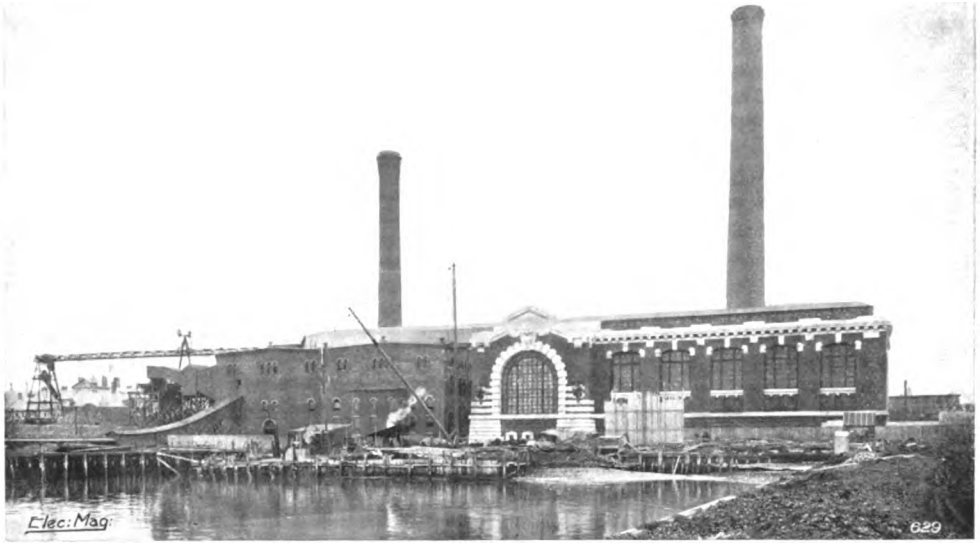
This latter station is at L Street, and is being equipped with a monster extension plant of Curtis turbines, which, when completed, will aggregate 60,000 kw. Over this plant the party were conducted, and as one of the turbines had just been completed, the greatest interest was taken in it. The comparison between it and the plant in the old station adjoining, comprising reciprocating engines, clearly pointed to the trend of progress in constructing dynamo electric machinery. Each 5,000-kw. unit occupies less than half the floor space of one of the 1,500-kw. sets used in the old station. Complete condensing plant surrounds the turbine, a surface condenser being used, of 20,000 sq. ft. surface, with four passes for circulating water. The auxiliaries are all steam driven, and compared with the turbine and generator above them look very small fry exerting themselves to apparently little purpose. The switch house is between the old and new stations, and well placed for a neat arrangement of the cable connections. A coal storage adjoins the power houses, accommodating

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60,000 tons, and the yard is served with two towers and distributing cranes. The connected load on the system of incandescents in 1904 was half a million lamps, of motors 23,000 h.p., and of arcs 9,000 lamps. The company's gross revenue during 1904 was £625,103, and its operations from the outset testify to the capacity for organised concentration possessed by American engineers.

Boston Telephones.

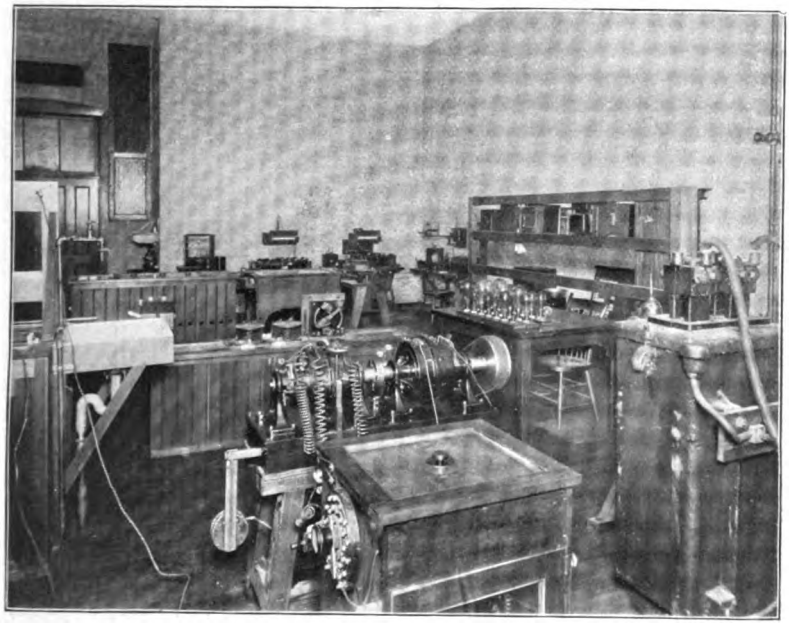
A tour of inspection was then made of the headquarters of the American Telephone and Telegraph Company, and the New England Telephone and Telegraph Company in Milk Street. The former body has arisen out of the early efforts of Alexander Graham Bell, who invented the telephone in Boston, and has now the greatest controlling interest in telephone business throughout the United States. It is a wonderful organisation vested with extensive powers, and the use of these has given America, but more specially New England, telephonic facilities surpassed by no other community in the world. The development of the business is a history in itself, and we can only spare space for a few figures, which are, however, sufficiently suggestive. In 1881 some 50,000 subscribers used telephones, and in 1904 this number had been swollen to 1,525,167, excluding those on metallic circuits who numbered 1,377,134. With but a few cities, towns, and villages using the telephone in 1881, some 26,128 were coupled to the Bell system in 1904. The total mileage of exchange wire now underground is 1,618,691, while the total exchange wire mileage is 2,983,189. The employees have increased from 5,000 in 1883 to 61,135 in 1904. The business done on telephone lines as compared with that of telegraph lines shows a substantial balance in favour of the former. Some ninety-two million telegrams are transmitted in the United States during the year, representing the achievements of sixty years. Telephone calls exceed this number of messages each week. The upbuilding of this great monopoly is characteristic of what can be done by the systematic development of an idea. The world is indebted to a Boston man for the telephone, and America owes its telephone industry to the business acumen of a few far-seeing Boston financiers.



EXTERIOR OF L STREET STATION, BOSTON.

The New England Telephone and Telegraph Company is the operating Telephone Company for New England. Its largest exchange at Boston has 34,602 subscribers, and of the surrounding districts

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RESEARCH LABORATORY, MASSACHUSETTS SCHOOL OF TECHNOLOGY.

and towns there are 18,955 stations, the largest being at Worcester, Massachusetts, with 6,000 subscribers. Even small villages have an exchange. The exchange and toll connections daily average 640,000.

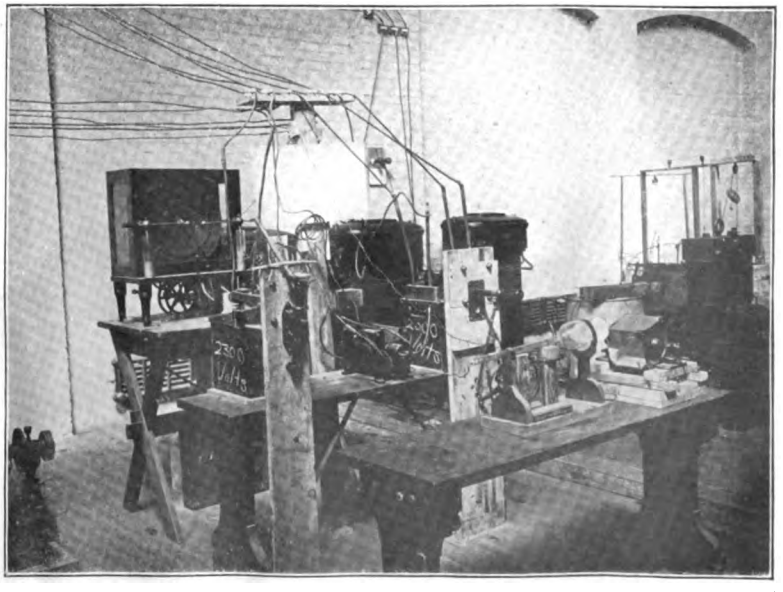
At Harvard.

At Pierce Hall, Harvard, Dr. A. F. Kennelly met the party, who were shown over Pierce Hall, the Jefferson Physical Laboratory, Memorial Hall, Germanic Museum, and Harvard Union.

The University buildings came in for much praise and comment. The electrical engineering section located in Pierce Hall is well equipped, and a four years' course has been established since 1888. The technical education at Harvard is closely affiliated with the other arts and sciences taught in the University. The McKay bequest of five million dollars for applied science, especially mechanical and electrical engineering, will be available in five or six years, and with this, technical education at Harvard will be placed on a more extended basis. There is a flourishing engineering society, with branches, among others, in mechanical and electrical engineering.

A Great Technical School.

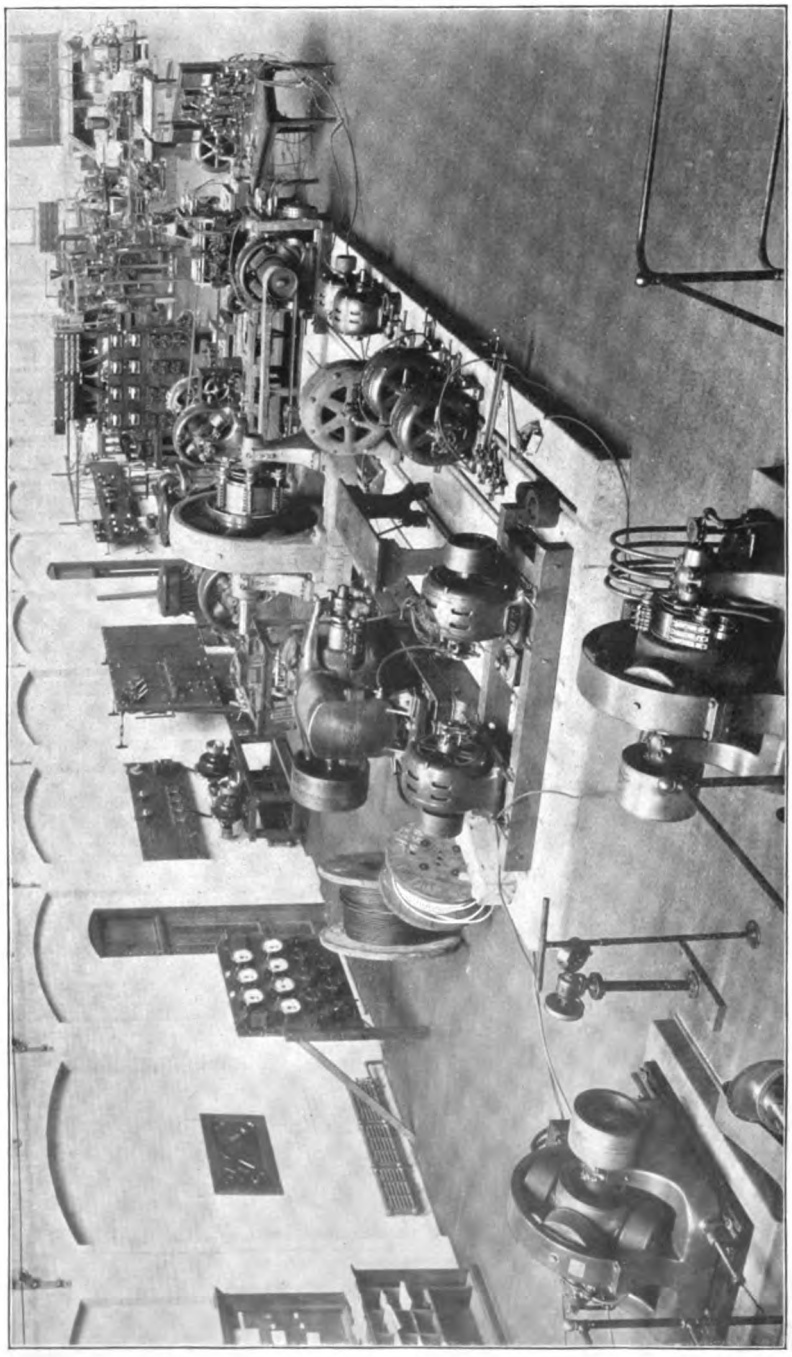
In the afternoon the Massachusetts



HIGH PRESSURE TESTING ROOM, MASSACHUSETTS SCHOOL OF TECHNOLOGY.

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Massachusetts School of Technology.



Large Dynamo Testing Laboratory.

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School of Technology was inspected with intense pleasure. The original project, launched some forty years ago by Prof. W. B. Rogers, was to furnish a complete system of industrial education. The Institute has had generous aid from the State of Massachusetts by grants of money and land, but the bulk of the endowment is due to private beneficence. We were welcomed in the Rogers Building, and then went the round of the various departments. The electrical department is twenty years old, and many illustrious electricians were early trained within its walls. The Lowell Laboratories, recently completed and equipped with modern electrical apparatus, bear favourable comparison with anything of the kind yet done in the world's technical training centres. In the curriculum special stress is laid on the fundamental value of physics, mathematics, and electrical theory. The electrical engineering department has been located in the Augustus Lowell Laboratories since 1903, these covering an area of 45,000 sq. ft. The dynamo laboratory impressed us very favourably both from the point of size, and also from the modern design of its equipment. The power plant was of ample output, and contained several forms of generating units both engines and dynamos. We inspected several other departments, but not of essentially electrical interest.

NEW YORK.

On Sunday, September 4, we were the guests of J. G. White, Esq., a member of the New York Reception Committee. Mr. White had thoughtfully arranged a trip for us on the Hudson River in the steamboat *Richmond*, and over six hundred persons took advantage of his hospitality. As the head of an enterprising and important contracting concern, Mr. White needs no introduction to our readers. We may remind them *en passant*, that his Company has very widely extended its sphere of operations and now embraces every branch of engineering constructional work. The offices occupying the 21st and 22nd floors of the Wall Street Exchange Building, are probably the most sumptuous of their kind in New York. The building housing them is one of the tallest in the city, and commands a magnificent view of the surrounding territory. Of the construction, engineering, operating, and financial departments we can, from lack of space, say little, save that they are organised on business principles, and run on the very latest commercial lines. Of the presiding spirits, Messrs. F. H. Reed, P. G. Gossler, G. W. Bunnell, junr., and H. S. Collett, we can speak from pleasant personal acquaintance, as under their auspicious guidance the river trip was pre-eminently successful and enjoyable. Of all its recent electrical contracts, that



SKY SCRAPERS AS SEEN FROM WALL STREET EXCHANGE BUILDING.

of a complete power and lighting plant for Manilla, Philippine Islands, is the most important, and with this rank the electrical inter-urban railway connecting Youngstown, Ohio, with its adjoining towns: the construction and equipment of the electric line near St. Louis for the Alton Granite and St. Louis Railway Company; and the construction of the high-speed Inter-urban Electric Railway for the Indiana Northern Construction Company, all very extensive schemes. The difficult task of providing the overhead equipment for the car service on the new Williamsburg Bridge, N.W., was also entrusted to, and successfully carried out by

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the company. This was an extremely awkward piece of work owing to complicated terminal arrangements, but its efficient operation has, since its completion, been very highly commended by experts.

On Pleasure Bent.

Our visit to New York would have been incomplete without an inspection of the world-famed Coney Island and, doubtless, Mr. White felt this to be the case seeing that this was the end and object of our journey. Its illumination forms a valuable source of revenue to the Brooklyn Edison Company, from whose mains it is supplied. The lamps number upwards of 300,000 and represent a load of 9,000 kw. This amount of power, of course, is only demanded during the summer months. There is a decorative tower in the centre of "Dreamland," which alone contained 42,000 lamps, and 1,000 of these studded in a ball at its apex. Special provisions were required to furnish the power and light to this artificial paradise. The Edison Company's lines were not extended to Coney Island until 1897, and at that time the movement was regarded by certain members of the management as a doubtful venture, but since this the company has done its full share towards the development of the amusement business. When "Dreamland" was first planned six miles of cable subway were required, and extra sub-station plant of 5,000-kw. capacity as well as the building to house it, the whole involving an expenditure of £60,000; still the company has been well repaid for its foresight. The stupendous task of transporting the holiday crowds, numbering up to 375,000 people per day, reposes upon the Brooklyn Rapid Transit Company, and by the electrification of their lines they were enabled to successfully handle this volume of traffic. Seven surface and five elevated lines run to West Brighton or Coney Island proper. Four surface lines and one elevated run to Brighton beach and two surface and one elevated line to Manhattan beach. These give the company a total carrying capacity of 30,000 persons per hour. The terminal facilities at Coney Island have recently been remodelled, and thousands of dollars spent in improving the accommodation.



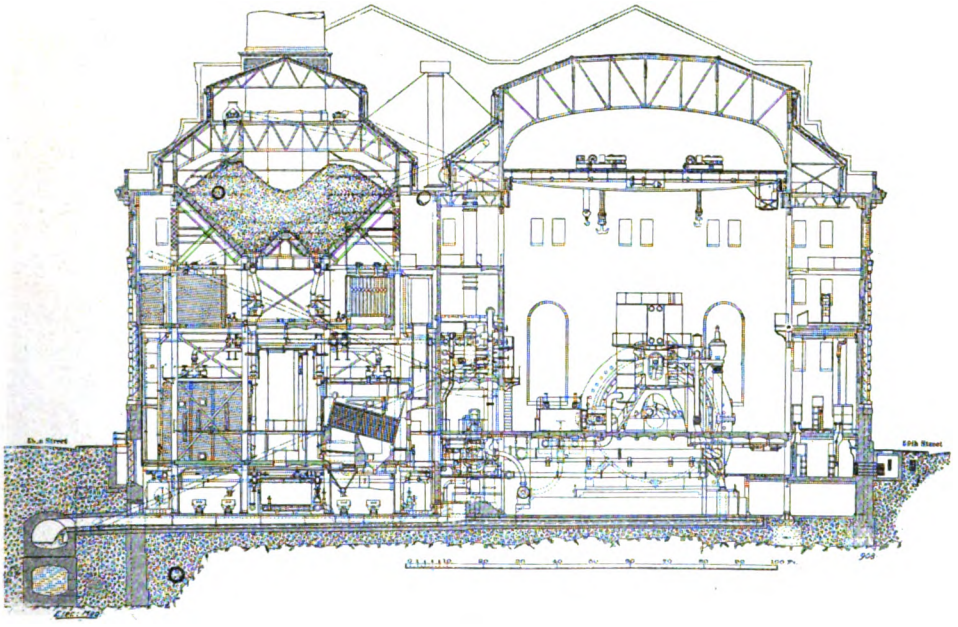
NEW YORK FROM A WINDOW OF THE OFFICES OF J. G. WHITE AND CO.

New York Subway.

On Monday, September 5, we made our first run over the lines of the New York Subway, a pioneer train of eight cars, each carrying eighty passengers, having been specially placed at our disposal. The construction of this subway is an engineering feat, which, at present, has no parallel in the world. Work was commenced on March 24, 1900, and the subway was opened on October 27 last year. The contract included a four-track subway from City Hall to 96th Street, 6.71 miles; a three-track extension to Kingsbridge of 3.8 miles and three miles more of two-

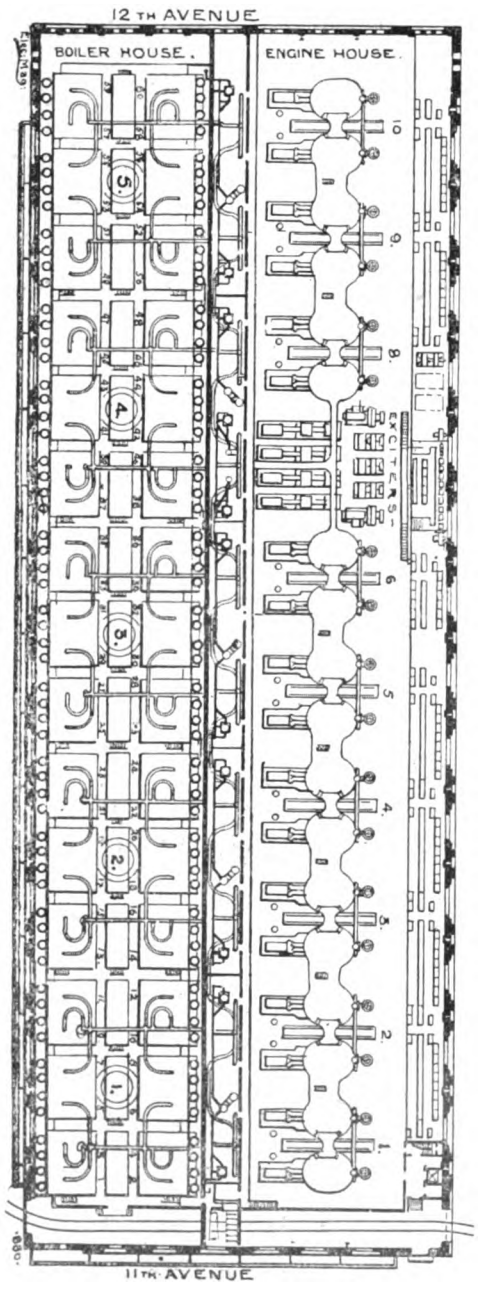
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track construction; the extension to Bronx Park of 2.89 miles of three track, and 4.24 miles of two-track construction, representing a total of 20.69 miles or sixty-three miles of single track. The subway portion of 10.6 miles, built with steel columns supporting the street and 4.5 miles of concrete arch construction, has involved engineering difficulties of the most aggravating character. From what we were permitted to see of the stations, no effort has been spared to afford easy access from the street. There is no need to wait for a lift, as the descent of a few broad stairways brings one directly to the platform. The rolling-stock is mostly all fire-proof, several of the cars in which we travelled being of all steel construction. Five car trains run in the local service, these comprising three motor-cars and two trailers. The expresses are eight car trains, having five motor-cars and three trailers. The motors are all operated on the multiple unit system, which allows of the complete control of all the train motors by one man from either end of the train. Should the train become parted for any reason. the brakes are instantly and automatically applied. The car wiring is run in flexible metal conduits, so that all risks of fire from this source are eliminated. The express trains develop 2,000 h.p. each, the motor tracks accommodating two 200-h.p. motors, one on each track. The contract given out was for 880 of these motors and 700 cars. 430 motor- and 270 trailer-cars were also ordered. The subway and cars are lighted, from a separate power source, by some 8,700 lamps, 3,000 of which illuminate the tunnel. Fifty-two thousand three hundred kw. of electrical energy is needed for the operation of the maximum number of trains. An automatic block signal and inter-locking system controls the service, the various devices being electro-pneumatic in action. An alternate-current circuit is used for the signal relays to make them irresponsive to differences of potential occurring in the direct-current rail. Emergency brakes are fitted to the trains, and these engage with stops on the permanent way which are raised to any train disregarding a danger signal. Seven 30-kw. motor generator sets in the sub-stations furnish energy for the signal lighting and track circuits. There are relays on the signals which close a local battery circuit for



End Section of New York Subway Power House.

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PLAN OF SUBWAY POWER HOUSE.

operating the magnet air valves. Throughout the length of the line a 2-in. pipe is laid, supplying air at 60 to 70 lbs. pressure for the pneumatic motors on signals, points, and automatic stop devices. Motor-driven air compressors of from 8 to 37 h.p. in the sub-stations supply air to this pipe.

Subway Power House.

Next inspected was the monster power house furnishing energy to the subway trains. This is a grand monument to the energy of American engineers. Although we have something of the sort in Lots Road Power House at Chelsea, it would be difficult to find in this country so splendid an array of boilers, engines, generators, and switch-gear under the roof of a single station. The fact that the plant was designed before large steam-turbines had been developed to their present efficient state, precluded their introduction on an extensive scale in the design of this plant. Still, they have not been overlooked, and the lighting of the subway and its trains has been entrusted to four 1,250-kw. horizontal turbine generators.

At this point we will trace briefly the uprising of this magnificent plant. The foundations for building and machinery are on solid rock. The building is 201 ft. wide by 690 ft. long, and is divided in accordance with modern practice into three sections, for boilers, engines, and generators, and switch-gear respectively. The boiler house at present contains sixty-five Babcock and Wilcox horizontal water-tube boilers. Of the six stacks which will ultimately crown the structure, four are at present built, and are of Custodis hollow brick, rising 225 ft. above the grates. With commendable foresight the machinery has been divided into sections of six units each consisting of one stack, twelve boilers and two engines.

The Engines.

In the engine room are nine Allis-Chalmers engines comprising two compound engines, with cylinders in quadrature, running on each side of a central generator. These magnificent machines are rated at 7,500 i.h.p. when running at 75 r.p.m. with 175 lbs. steam pressure and 26 in. vacuum. In conformity with the usual practices each unit has its own condensing plant, and in the present instance the auxiliaries are all steam driven. The alternators are Westinghouse machines furnishing three-phase, twenty-five cycle current at 11,000

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volts pressure, the normal output being 5,000 kw. The excitation for the revolving fields is derived from 250 kw. direct-current units. Two of these are driven by 400 h.p. marine engines, and three by 365 h.p. induction motors. As a stand-by exciting source, a storage battery capable of exciting all the generators for an hour is installed. The switch-gear, which is motor operated, and distance controlled, is placed on galleries built along one wall of the engine room. The control board is really a miniature of the entire system and gives a complete diagram of all connections, so that everything is under the immediate eye of the operator. On leaving the station one could not help feeling that in its design, construction, and equipment a difficult task had been accomplished, but in spite of this the impression remained that even greater improvements in the concentration of power-plant, and the economic generation of electrical energy might yet be effected.

At Kingsbridge.

A trip down the river on the *Nassau* brought us to the Kingsbridge Power House, where we inspected an entirely distinct type of plant, under the guidance of Mr. M. G. Starratt. This station furnishes energy to the New York City Railway. Of the sixteen 3,000 - kw. units contemplated to form the complete station, eight have been installed. The engines are Corliss triple expansion type, driving 3,000 kw. alternators at one end of the shaft. The units are arranged in two rows forming four groups of four generators. The boilers are in two tiers of two rows running parallel to the engine room, with coal pocket above and steam piping below. The condensers are arranged separately in the boiler house, and each is capable of dealing with 25,000 h.p. of plant. The switch-gear is in the engine room and overlooks the generators. Considerable interest was taken in this, as the switches are air operated, an unusual feature of American practice. A small compressor furnishes the necessary air. The station supplies three-phase twenty-five cycle current 6,600 volts

The Elevated Power House and Lines.

The Manhattan elevated power house at 74th Street was next visited, but this proved to be almost a replica of the subway plant. It contains eight 5,000-kw. units driven by Allis-Chalmers 8,000 h.p. engines each with its own condensing plant. The boilers in contra-distinction to those at the subway power house are in two tiers. At this juncture it may be interesting to cite a few figures regarding the Interborough Rapid Transit Company, which operates the Manhattan elevated lines and also the subway. These lines were leased to the company in April 1903, as it then assumed the control of the system under new electrical operating conditions. The stockholders in the original system as operated by steam, decided, in 1899, to convert to electric driving, some £3,600,000 additional stock being issued to effect this improvement. The favourable experience in the electrical operation of the Chicago elevated lines in 1893 prompted this course, and the first train was put into service in January 1902. Eighty per cent. of the traffic was electrically hauled twelve months later, and the last steam train was taken off on June 24, 1903. As a consequence of this conversion, the carrying capacity of the system was increased by 33 per cent., the passenger traffic during 1903 being represented by this increase over that obtained under steam conditions. The most convincing argument for the change, however, is to be found in the fact that the cost of operation was less than 45 per cent. of the gross receipts, while under steam its cost was over 55 per cent. It is interesting to note that at the power station alone some three hundred men are needed ; ninety-nine of these are engine-room hands, and one hundred and thirty ply their labours in the boiler house.

Our American friends have had enormous difficulties to meet with sleet collecting on the third rail. Until a satisfactory method was found, the service was not infrequently held up, but now a cast-steel sleet scraper is in use, which enables trains to run without delay during the severest weather. This scraper comprises six parallel blades set diagonally across the rail at an angle of sixty degrees. A pressure of 140 lbs. is given to the scraper by a flat steel spring, the weight of the casting giving an additional 25 lbs. pressure on the third rail.

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The Great Waterside Plant.

We next moved down the river to the Waterside Station of the New York Edison Company, and were here afforded the treat of the day in inspecting what is really a wonderful plant. To appreciate the chief features of this station it is necessary to glance briefly at the circumstances which have given rise to its construction. Unlike London, the electricity supply of New York is in the hands of one controlling authority—the New York Edison Company—and the development of its organisation would fill a volume of no mean dimensions.

Commencing in 1878 as the New York licensee to the Edison Electric Lighting Company, it operated Mr. Edison's patents relating to electric lighting. The historic Pearl Street Station commenced supply in 1880 with a total capacity of 750 h.p. and a load of about 1,000 lamps. The system has been expanded from this embryonic effort until it now embraces the twenty-two square miles of Manhattan, and forty-one square miles of the Bronx, serving a population of 2,525,000 people. This is, of course, excluding the area of the Brooklyn Edison Company. The original three-wire system has been retained, and unlike the prevalent 200-volt practice of this country, a pressure of 120–240 volts became standard. The load of the stations at Duane, East and West Streets—plants erected to meet the growing demand—is being gradually transferred to the one monster station, that at Waterside. The smaller plants will ultimately become sub-stations, furnished with energy from this central power source.

The Equipment at Waterside.

With the thought that the most important area of New York would be ultimately supplied from the plant we may better enter upon a brief description of the Waterside Station. The original scheme was for a plant of sixteen 5,500-h.p. units, but in the light of recent developments with turbines, only eleven of these have been installed. They are housed in the engine room, 115 ft. wide, 267 ft. 10 ins. long, and 125 ft. high. In the boiler house, starting from the basement, are the auxiliaries, two floors of boilers, of which there are fifty-six, and the coal "pocket," having 10,000 tons capacity. Four steel stacks top the building, rising 196 ft. above the grates. Steam is delivered at 200 lbs. per square inch, and a complete blowing plant is included in the equipment. Twenty boilers have automatic stokers, and the rest are hand fired.

Below the engine-room basement are four condensing water tunnels leading to the East River, and in the basement itself condensing plant for each unit is fixed, with the oil filters and pumps. The engine room designed for 16–8,000 h.p. units contains eleven of these at present, the engines being marine compound with two low-pressure cylinders, and the generators are revolving field machines each of 3,500 kw. capacity. The engine cylinders measure: high pressure, 43½ ins. and low pressure, 78½ ins. with 60-in. stroke. The shaft is 30 ins. diameter, and carries a 23-ft. fly-wheel weighing 90,000 lbs. in addition to the revolving field system which weighs 125,000 lbs. The generators are wound for 6,600 volts, and furnish three-phase twenty-five cycle current. The collector rings are of iron with carbon brushes. Excitation is from induction motor generators, at 200–280 volts, with battery standby capable of exciting sixteen machines for one hour. The switch-gear is fixed on a series of galleries in the engine room, and is the usual motor operated, distance controlled arrangement.

Extensions are now in progress with Curtis steam-turbines of 5,000-kw. output, the three units installed appearing ridiculously insignificant beside the more roomy units, though they were nearly double the output. This comparison of turbo-units with reciprocating sets of large size was the best we were afforded during the tour.

A new Waterside station adjoining the present one is under construction, and will contain 100,000 kw. of plant. Turbines vertical or horizontal, or reciprocating engines have not yet been decided upon.

A unique feature of this extensive supply system is the large battery plant presumably held in reserve but in constant use at "peak" time, the aggregate capacity representing 25 per cent. of the total of the various plants of the company.

We were unable to see much of the other great electric railway developments

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now rapidly proceeding in, and round New York. The New York Central Railway, which is to operate shortly the world's largest electric locomotives, is of surpassing interest, while no less so is the work of tunnelling from Hoboken to Long Island, to provide a road into New York City for the Pennsylvania and Long Island railroads. This herculean task involves twenty-eight miles of tunnel in which electric trains will run to connect the steam lines at each end, and also to feed the station in the centre, in New York. Power houses will be located on Long Island and in Jersey city, and will respectively have capacities of 66,000 kw. and 44,000 kw. in 5,500 kw. units. Upwards of one thousand men are now engaged on the scheme, which may well be regarded as the most ambitious and daring of its kind yet attempted.

SCHENECTADY.

THE mammoth works of the General Electric Company were the most extraordinary we were privileged to visit, extraordinary in their original conception and even more extraordinary in their subsequent developments. Founded in 1886 as the Edison Machine Works, the Company has expanded until, under its present name, it was incorporated in 1892, acquiring the capital stock of the Edison General Electrical Company, the Thomson-Houston Electrical Company and the Thomson-Houston International Electrical Company. This amalgamation of these large existing Companies was considered essential as conducive to more harmonious working.

Acres of Buildings.

This mammoth concern consists of some 150 buildings, covering a total ground area of 130 acres, and representing a floor space of 57¾ acres: some ten thousand hands are employed throughout the entire works.

The electrical devices of one kind and another taken up and developed by the Company are too numerous to mention. Its engineers have been associated with some of the boldest and most ambitious electrical schemes, the chief of these being the conversion of the energy of falling water into electrical energy and its economical transmission over great distances. In this respect the Company participated in the original utilisation of water-power on these lines at Niagara.

The adoption and standardisation of the Curtis steam turbine is well worthy of the Company's previous records; we passed through the turbine-testing and erecting-shop, a new building, and there saw machines in various stages of development and in sizes from 500 to 5,000 kw. Examples of the latter we had previously inspected at the L Street Station, Boston, and Waterside, New York.

In heavy electrical traction the mammoth locomotives which will soon be hauling the new electric trains on the New York Central Railway also stand to the credit of the Company. So far it would seem that this huge organisation has been connected with nearly every phase of electrical development. There is, however, one field which it does not appear to have yet entered, that is the manufacture of large reciprocating steam-engines or of gas-engines. It is worthy of note that all the machine tools in the works are operated by direct-current motors. The energy for these is furnished from two steam power houses on the works, and also from Spiers Falls some forty miles distant.

Transmitted Power.

Power is transmitted from this hydro-electric station at some 25,000 volts; and energy is supplied in addition, to the Schenectady Railway Company. The Hudson River Power Company operates the Spiers Falls plant and also a smaller plant at Mechanicville. In all, nine manufacturing, railway, and lighting Companies take power from this transmission system.

There are many interesting places round Schenectady, and of these we may mention Union College, which has an excellent engineering school and an electrical engineering department under the eminent leadership of Dr. C. P. Steinmetz. These places, however, we were not permitted to visit, and soon found ourselves being hurried onward once more.

The Single-phase Railway.

The connecting link between these great works and our special train to Saratoga was the new single-phase line between Schenectady and Ballston Spa. This formed the crowning feature of a visit crammed with interest. The motors on the car are operated either by direct

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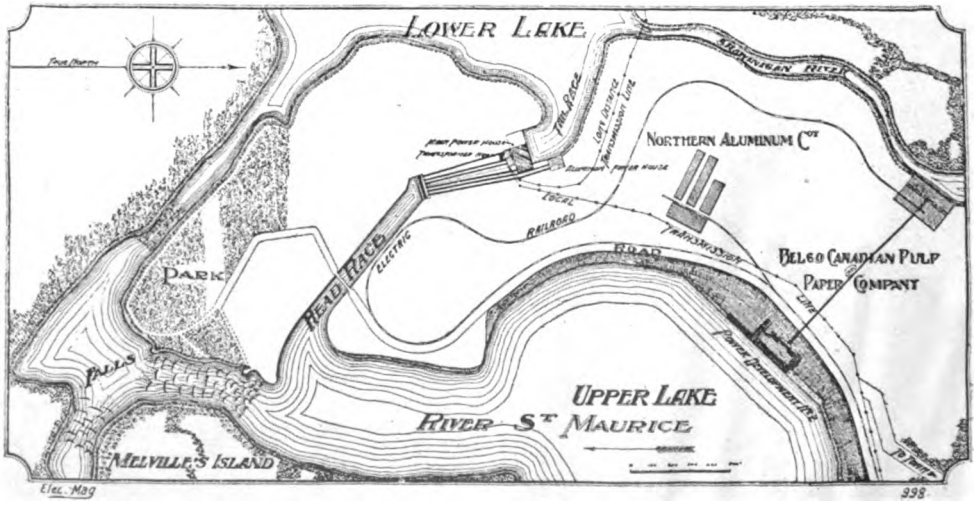
or alternate currents; as a direct-current car they receive energy from the usual 500-volt trolley-line; when operating from alternate currents the trolley voltage is raised to 2,000 and the motors run from a transformer giving 500 volts. The party on the car were able to inspect the commutators of the motors through a transparent opening in the floor, so that any tendency to spark was at once observable. This system is the latest contribution of the General Electric Company's engineers to electric railway practice and bids fair to have very wide acceptance. We look forward to developments on some such lines in and around London.

MONTREAL.

Our visit to Montreal on September 7 at once reminded us of the great hydro-electric achievements of the city.

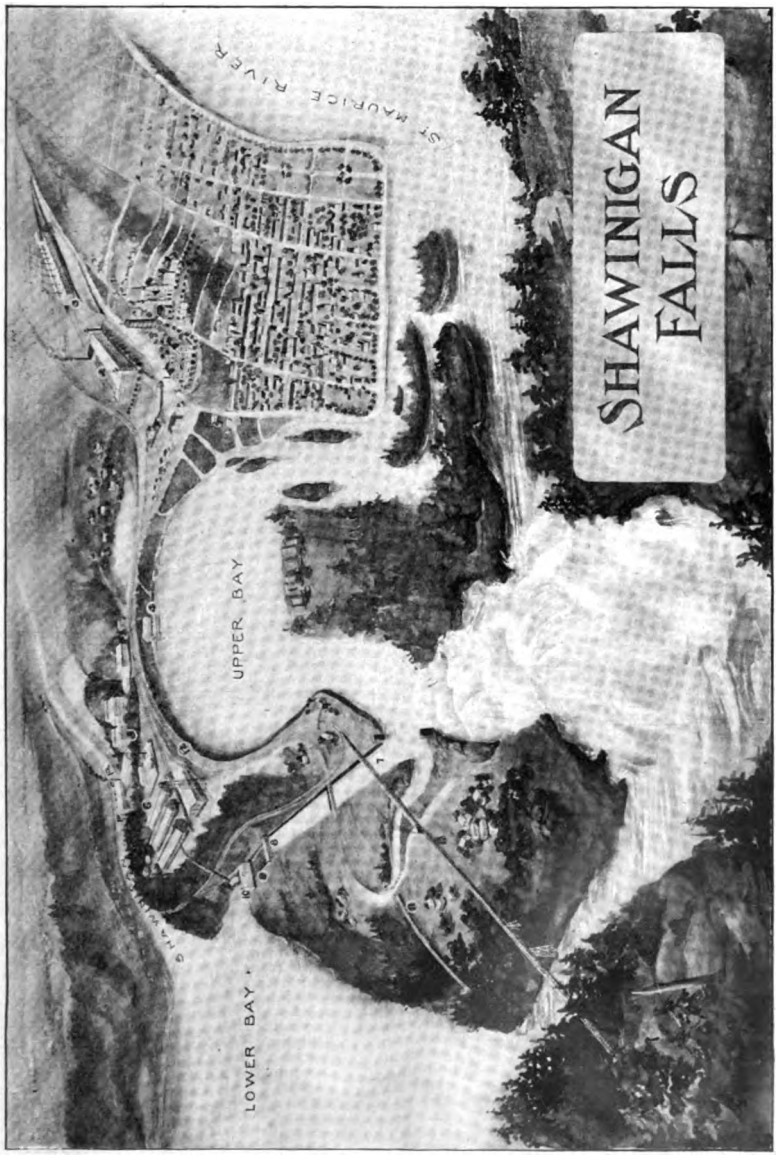
From an electrical point of view Montreal occupies a unique position. It consumes more transmitted electrical energy than any other city in the world. This energy is furnished from three power houses at Chambly, Lachine, and Shawinigan. The rivers harnessed to furnish this power are the St. Lawrence, Richelieu, and St. Maurice, and the energy is transmitted at 5,000, 25,000, and 50,000 volts respectively. In the early days the supply of power was in the hands of several small companies, but naturally these have since come under the control of a central organisation—the Montreal Light, Heat, and Power Company. Of the three power houses we visited, those at Lachine and Shawinigan were open for our special inspection. This treat was, however, reserved till the next day.

Luncheon was served in the large sub-station of the Power Company and speeches made with difficulty amid the roar of the machinery. This is more particularly referred to in Mr. Feilden's story in the first part of the magazine. In the afternoon a reception was held at the McDonald Engineering Building of the McGill University. The electrical department of this excellent institution is in charge of Dr. R. B. Owens. The equipment of the laboratories, of which there are five, is very complete, more especially that set apart for special electrical investigations. In view of the high-voltage power schemes so common in the district, the high-tension laboratory was exceptionally interesting, it being equipped with testing transformers which will give up to 50,000 volts. The entire apparatus of this laboratory has recently been removed to a fire-proof concrete room especially built for it. The undergraduate course is maintained through a curriculum covering four years. Two of these are spent studying mathematics, electrophysics, drafting, &c., the remaining two being devoted to applied electrical-engineering.



Plan of Shawinigan Falls, showing Power-Plant.
By courtesy of Shawinigan Falls Power Company.

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1. Hotel. *4. Second Development.* *7. Canal.* *10. Power House.*
2. Liner Hill. *5. Pulp and Paper Mill.* *8. Bulkhead.* *11. Log Slide.*
3. Carbide Works. *6. Aluminium Works.* *9. Penstocks.* *12. Electric Railway.*

By courtesy of Shawinigan Falls Power Company.

At Shawinigan.

The inspection of the Shawinigan Falls and power-plant, some seventy miles from Montreal, occupied practically the whole of Thursday, September 8. The Falls were first visited, and elicited considerable comment and admiration. At present they furnish some 15,000 h.p. to the eighty-four mile transmission line, but operations are in progress to increase this by 20,000 h.p. The present plant comprises three pairs of turbines, three pairs of Francis wheels running at 180 r.p.m. and delivering 6,000 h.p. These are connected to 3,700 kw. generators, giving two-phase thirty cycle 2,200 volt current. The first two are Westinghouse machines, but it is interesting to note that the third hails from the mother country, being supplied by Dick, Kerr and Company of London. A fourth unit with the capacity of 10,500

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h.p. is now being installed. A local service up to twenty miles is given through step-up transformers at 25,000 volts.

Lines and Transformers.

The long-distance transmission is supplied at 50,000 volts, the current being changed to three-phase for transmission. The transformers are oil cooled and housed in a separate building extending over the tops of the penstock. A special device is fitted to each transformer case to afford protection against possible explosion or fire in the transformer room. This was designed by Mr. R. D. Mershon, consulting engineer to the Shawinigan Water and Power Company. Explained briefly it provides for the speedy displacement of the oil in the tank by water, the oil being forced into the sewer. This method is safer than drawing the oil from the bottom of the case, as air is not admitted and an explosive mixture cannot be formed. The transmission line comprises three aluminium cables, each composed of seven No. 7 aluminium wires, and the cables are arranged in an equilateral triangle at sixty inch centres. The insulators previously tested at 100,000 volts for one minute are in three parts, held together by Portland cement. They rest on hickory pins boiled previously in stearic acid. As the Company contracted to supply the Montreal Light, Heat, and Power Company with sixty-cycle current, they have had to instal frequency changers at the receiving end. These comprise thirty-cycle synchronous motors direct connected to sixty-cycle generators.

Of the industries around the Falls those of an essentially electrical interest are the Northern Aluminium Company, the Shawinigan Carbide Company, and the Electro Manganese Company. A stop was made on the way to Shawinigan to inspect the Carbide Works and other places. The latter manufacture ferro-manganese by a secret process in the electric furnace. The substance is largely used in the manufacture of high-grade steel. The Belgo-Canadian Pulp Company operate some large paper mills, the district with its extensive woods being naturally well adapted to such an industry. The plant here, however, is operated from a separate works with an ultimate capacity of some 15,000 h.p.

In close proximity to Montreal are the works of Allis-Chalmers-Bullock Ltd., covering some fifteen acres, represented by five shops. We refer to the manufactures of this company under the account of the exhibits at St. Louis. Montreal has naturally electric tramway facilities, and an excellent service is run by a local street railway company. The power is, however, derived from a separate station.

Lachine Rapids Plant.

The power house at Lachine Rapids was visited by another section of the party. This plant possesses many curious features compared with those at Chambly and Shawinigan. The turbines comprising six wheels have vertical shafts gearing into a horizontal jack shaft, at one end of which a generator is mounted. Eight units representing 8,000 electrical h.p. are installed, the generators being 750 kw. sixty cycle, 5,000 volt, three-phase machines running at 180 r.p.m. The power house is of exceptional length, no less than 1,000 feet, but is only 50 feet wide. The generator rooms containing four machines each are separated from the wheel house by partitions which, however, leave a clear central aisle. The switch-gear overlooks each group of generators from a gallery. A special signalling code is used and the switchman has complete control of the turbine governors from the operating table.

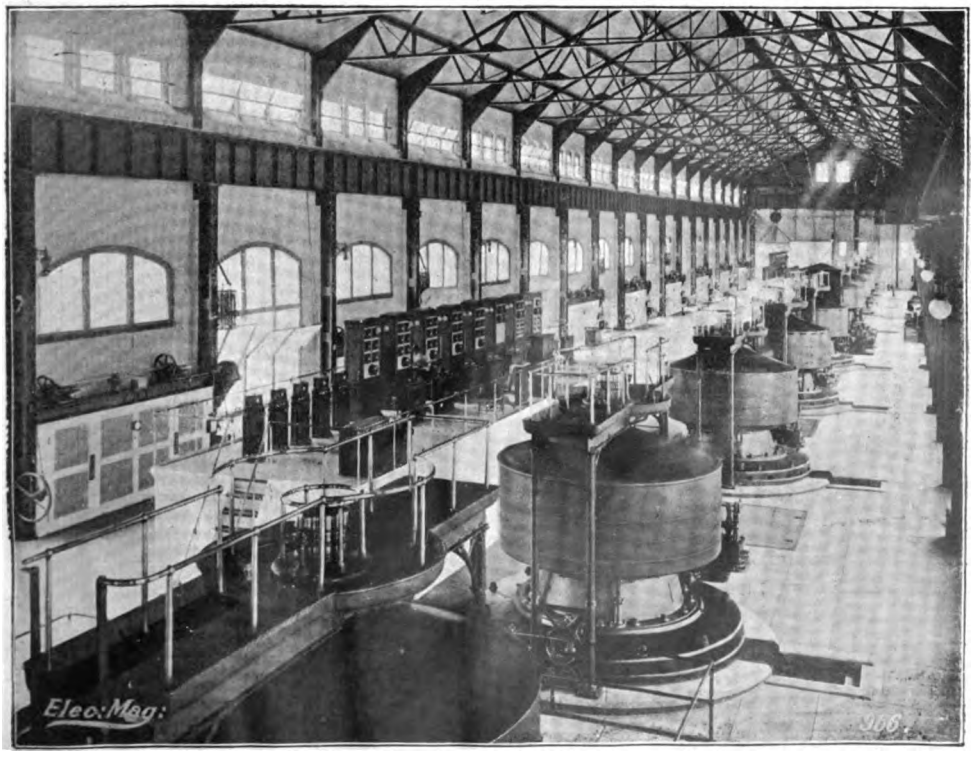
Power is transmitted over ten three-phase lines to Montreal some five miles distant. This power-plant may be regarded as a masterpiece of engineering as it illustrates in a remarkable manner what can be done in obtaining power from falls as low as sixteen feet. It is doubtful whether the Shawinigan party had the better of the two trips, though an inspection of both plants by all the party would have doubtless been appreciated had time permitted.

NIAGARA FALLS.

THE American Tour would not have been complete if Niagara had been omitted from it. Electrical engineers the world over saw in the utilisation of power from this great cataract the beginning of all methods of transmission of hydro-electrical energy to great distances.

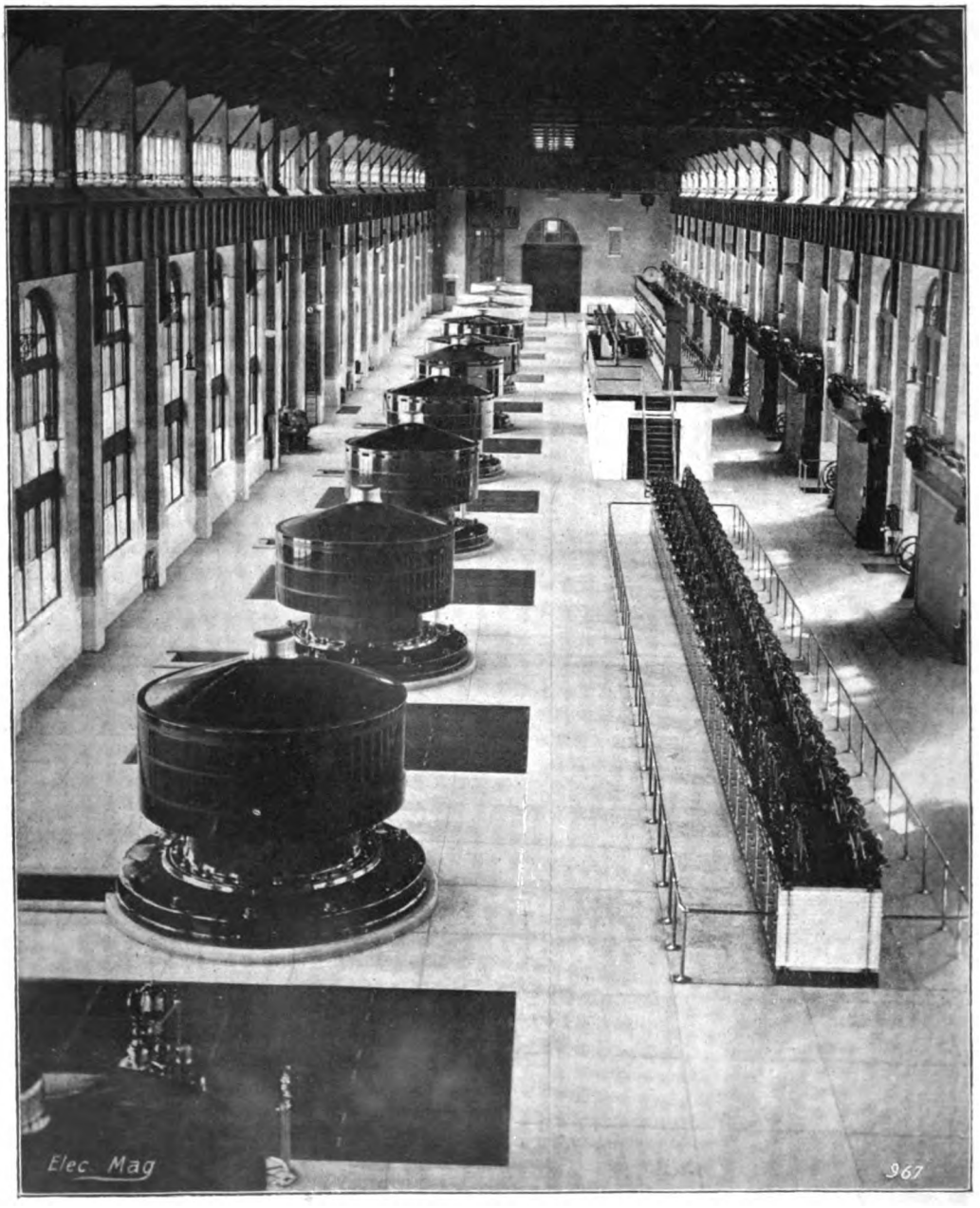
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The local Reception Committee with Mr. G. W. Davenport at its head immediately put us at our ease on arriving. A trolley-car ride took us down the Niagara Gorge. This superb beauty spot of America is dealt with in Mr. Feilden's story. At Victoria Park, on the Canadian side, the party proceeded to inspect the great power-plants now springing up around the Falls, the first to come under notice being that of the Canadian Niagara Power Company. This concern, allied with the Niagara Falls Power Company on the American side, is constructing a plant to develop ultimately 110,000 h.p. Quite recently 20,000 h.p. of this has been put into operation, and, at the time of our visit, the plant was particularly interesting. Water is taken from the river through a short canal and forebay, discharging through penstocks into turbines at the bottom of a wheel-pit and carried to the river through a 2,000-ft. tunnel. The generators are the largest so far constructed, developing 10,000 h.p., and when the plant is complete there will be eleven in operation. Strangely enough these monster units take up little more space than those giving half the power and consequently cost considerably less per h.p. The alternators are wound to deliver three-phase 11,000 volt, twenty-five-cycle current when running at 250 r.p.m. Arrangements are made to raise the voltage to 22,000, 40,000, or 60,000, depending on the distance of transmission. The stations of the Niagara Falls Company on the American side will ultimately be tied by cables to this new power house to enable the parallel running of the plant. The construction works of the Electrical Development Company of Ontario, Ltd., and also of the Toronto and Niagara Power Company were also visited. These represent a community of interests established for generating electricity to the extent of 125,000 h.p. The movement was the outcome of a desire felt by the citizens of Toronto that the Canadian side of the Niagara Falls might be utilised to furnish



INTERIOR NO. 1 POWER HOUSE. TEN 5000 H.P. GENERATORS.

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INTERIOR POWER HOUSE NO. 2. ELEVEN 5,000-H.P. GENERATORS.

them with light and heat. A syndicate composed of Messrs. F. Nicholls, H. M. Pellatt, and W. MacKenzie, who were the moving spirits, undertook the organisation and management of the Companies necessary for such an important power development. The work was begun early in April 1903, and has since been energetically pushed forward. The power is to be transmitted to Toronto and other points in Ontario. Local requirements have also been catered for by the purchase

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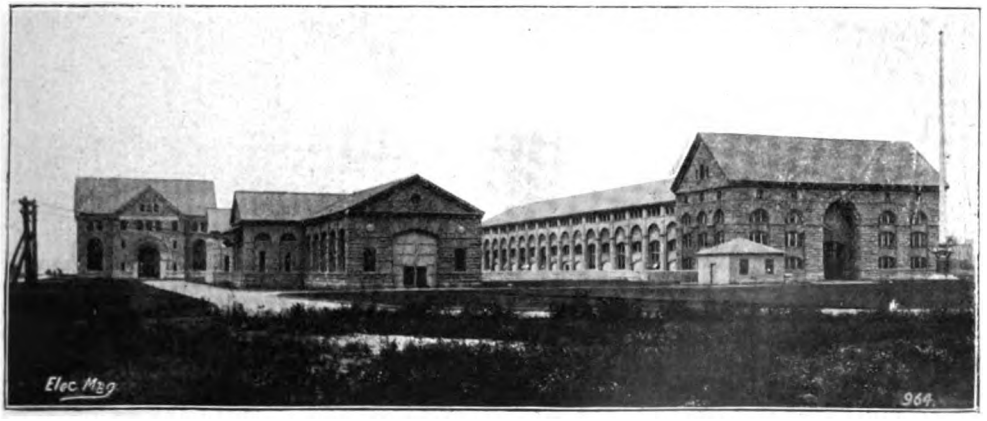
of land adjoining the power-plant, and upon this it is expected that various industrial plants, more especially electro-chemical works, will arise. There will be eleven 6,000-kw. generators furnishing three-phase current at 12,000 volts. The weight of each machine will be about 400,000 lbs., of which the revolving part will be about 141.000 lbs. The huge wheel-pit was in course of sinking on the occasion of our visit, and this gave an excellent idea of the magnitude of the undertaking.

Gigantic Schemes.

The Ontario Company has by far the most ambitious scheme in hand, developing 180,000 h.p. from the Falls. We were able to inspect its huge power house building directly facing the Falls. The hydraulic arrangements of this provide for an intake above the Falls, and three large conduits carry the water to the power house, which is situated at a lower level. By laying these pipe-lines a natural fall of 200 ft. has been obtained between the Dufferin Island—the point of intake—and the foot of the Horseshoe Falls. To this natural head nearly fifty-five feet is added by taking the water in at the above point. The pipe-lines, of which one was completing, will be of steel and the largest in the world, being eighteen feet in diameter. Each pipe will deliver about 3,900 cubic feet of water per second when connected to fully loaded generators, the velocity being fifteen feet per second. Eighteen generators, each of 7,500-kw. capacity, will be installed, furnishing three-phase, twenty-five cycle current at 12,000 volts. Two 500-h.p. direct-current machines will be needed to supply exciting current. The switch-gear will be housed in an entirely separate building some 550 ft. distant and some 250 ft. above the power house.

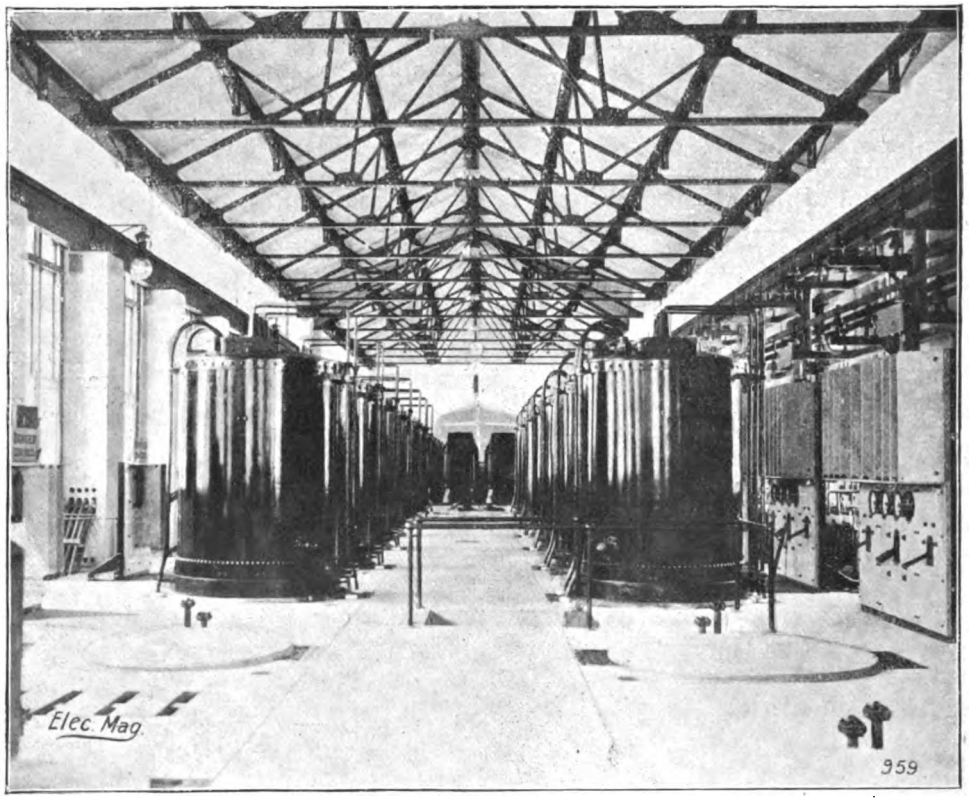
Historic Plants in Operation.

Of the operating companies the plants of the Niagara Falls Power Company excited the greatest interest. The pioneer plant in No. 1 Power House, about which so much has been written, has now reached the limits of its capacity of 50,000 h.p. The fears of engineers when this station was started that so much power could not be disposed of have proved altogether groundless, and, moreover, a second station of some 55,000 h.p. is now rapidly approaching the limits of its output. We went through this station, known as Power House No. 2, and stepping into the generating-room one hardly realised that the row of impassive-looking pedestals forming the generators was converting the latent energy of one of the world's greatest water falls into readily transmissible power. After some of the steam stations visited in New York the building had an air of delightful repose, though the absence of boilers to engineers hailing from a country essentially wedded to steam gave rather a peculiar feeling. The generators in both these power houses are operated from the upper end of a long vertical shaft at the foot of



EXTERIOR VIEWS OF POWER HOUSES, NOS. 1 AND 2.

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THE TRANSFORMERS AT POWER HOUSE, No. 2.

which is the turbine itself. With the exception of the last five machines installed, all have external revolving fields, and to a good many of us, watching these in operation was an unique experience. The later machines have, however, been equipped with internal revolving fields, as this method affords greater simplicity and accessibility to the various parts. In installing No. 2 plant, modifications suggested by the experience with that of No. 1 were introduced, but with the exception of this the equipment is practically identical.

A Pioneer Plant.

Although mentioned last in this record, the works of the Niagara Falls Hydraulic Power and Manufacturing Company were operating many years previous to the larger installations. This Company first operated dynamo electric machines at the Falls, but the energy was only used locally. Still, it has made some astonishing developments, and from a small plant first used in 1881 its output has steadily increased until it now stands at 34,000 h.p. Machines of almost every type and make were to be found in station No. 2, and the various groups of units are operated independently of each other, each being allotted the work of supplying some outside consumer. The Company has in contemplation a third power house with an ultimate capacity of 100,000 h.p. in 8,000-h.p. units. It is expected that the first section of this plant will be operating early in 1906.

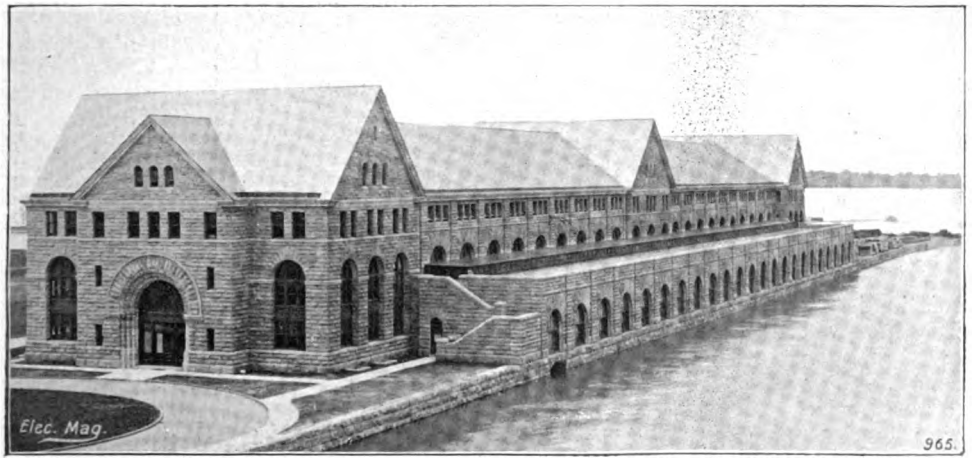
How the Power is Used.

Of the industrial developments around the Falls we were permitted to see little or nothing beyond the grand array of factory buildings everywhere evident. The largest customer of the Niagara Falls Power Company is the Union Carbide Company, taking a maximum of 15,000 h.p. Current is furnished to this firm at 2,250 volts and supplied to seventy-two furnaces of which fifty are in regular operation. The output

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of one furnace is about one ton of carbide per day. The Pittsburg Reduction Company ranks next in importance, taking 8,000 h.p. Of the distant plants, namely, those at Tonawanda, Lockport, Olcott, and Buffalo, the Buffalo Railway Company twenty-seven miles away are the largest consumers, taking 7,000 h.p., the Buffalo General Electric Company running them close with 6,000 h.p. By far the most interesting of the local plants is that of the Natural Food Company, who manufacture "Shredded Wheat" biscuits and "Triscuit" food products, now well known in this country. All operations of heating, lighting, and power are conducted by electricity, the wheat being in no case touched by human hands. Some eighty-seven induction motors are used and 8–140-kw. transformers supply current for the baking ovens.

We left the great centre of transmitted power very reluctantly, though the brief visit gave impressions of the scene and its associated industries which must ever remain stamped on our minds. In time the transformation of the giant energies of the great cataract will be instrumental in moving the scene of many American industries now operating elsewhere under adverse conditions, within sound, if not within sight, of this El Dorado of power.

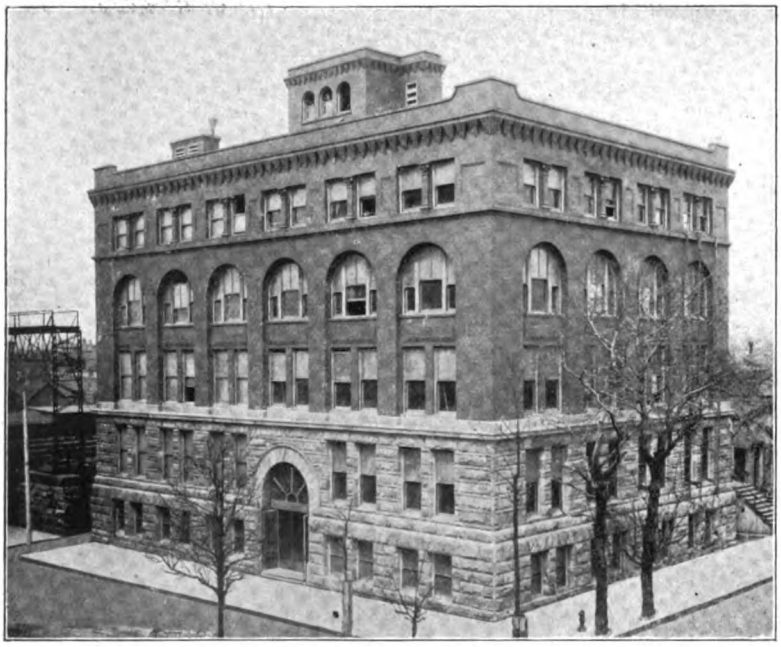


THE FOREBAY OF POWER HOUSE, NO. 2.

CHICAGO.

ARRIVED at the great meat-packing centre on Saturday, September 10, we spread ourselves over the city very much as we liked, the official programme not being strictly followed. The Fisk Street power house of the Commonwealth Company was certainly the chief object of electrical interest, this plant having been developed to supply the City of Chicago and the outlying districts. It operates in conjunction with the original Edison Company, which also furnishes energy for the down-town districts of the city. Chicago is peculiar in that its business area is crammed within a space of about a square mile, all the shops are here, also the business houses, and to make matters worse, the termini of the Great Railway Companies also concentrate upon it. At the Fisk Street Station three 5,000-kw. turbo generators were seen in operation, these were similar to those previously inspected, but the station possesses several unique features which tended to attract attention to it. The unit system has been adopted throughout, there being separate boilers, turbines, and switch-gear for each section. The boiler house is at right angles with the engine room, and in it are four rows of eight 512-h.p. boilers; one stack serves two rows of boilers. There are three generating units at present installed, each of these having its own condensing outfit; they operate at 500 r.p.m. at 180 lbs. steam pressure, generating three-phase current at 9,000 volts, the generators are delta connected with grounded neutral;

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MACHINERY HALL, ARMOUR INSTITUTE OF TECHNOLOGY.
(*See* "Tour Story," p. 30.)

regulation is effected by opening or closing thirty-six small valves delivering steam to the nozzles; this control is through the governor. The revolving portion of a machine weighs seventy tons and an oil pressure of 1,000 lbs. per square inch is needed at the footstep bearing; this pressure is derived from a motor-driven force pump. The switch house is separate from the main station, cables being carried underground to the gear: the switch gear is of the distance controlled type in two storeys; the lower storey contains the bus-bars placed horizontally on insulators, the second storey is equipped with switches and control board. The installation of fourteen complete units is contemplated, representing a total of 100,000 kw. This company also operates other smaller stations, and supplies at present 11,000 consumers with a connected load of 728,000 incandescent lamps and 9,220 h.p. in motors: it also furnishes energy to the Chicago Edison Company. The latter company operates a large steam-driven station at Harrison Street, which is equipped with a variety of plant, and this circumstance would probably account for its absence from the programme. Its total capacity is 6,400 kw. The consumers of the company which are supplied from the Edison three-wire network total 17,000 with 1,330,000 lights and 44,270 h.p. in motors. There are numerous other smaller stations, and these are being gradually converted into sub-stations.

Of the Chicago elevated railway we can say but little. Some ninety-one miles of single track are operated by four companies, three of whom have separate power stations for their lines, aggregating 25,900 kw., and the fourth company is served by the Commonwealth Electrical Company.

Telephone Matters.

The Automatic Telephone Exchange was also an object of considerable interest, from this some 10,000 subscribers are served. The tunnel system of the Illinois Tunnel Company was, however, by far the most interesting item of the visit; with original power to construct a conduit for telephone purposes the Illinois Telephone and Telegraph Company seized upon its opportunity and proceeded to undermine the business area of Chicago. From this, the present system of tunnels is developed, and over twenty miles have been completed and are partly in operation. Electric locomotives with a draw-bar pull of 8,000 lbs. will ply in the tunnels, current being picked up from the central rack which also enables the locomotives to come to the surface with a load. The tunnels are of concrete and horse-shoe shape; it is expected that in future building operations the basement of the building will be carried to the tunnel

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floor, and an underground freight yard will be thus provided. The tunnels are nearly thirty feet below the surface.

The Chicago Telephone Company, whose exchange was visited, is the chief telephone concern. It operates 149,233 miles of underground cables and 40,480 of aerial wires. There are now 114 exchanges, 101,187 telephones, and 81 toll stations, the total mileage of wire is 231,198.

Some interesting applications of electrical power have been made in and around Chicago. Of these the most important are the bridges over the Chicago River, twenty of which are now operated by electro motors, although there are still twenty-four moved by hand. In this respect electricity effects a saving of 25 per cent. over steam and 75 per cent. over hand labour.

ST. LOUIS.

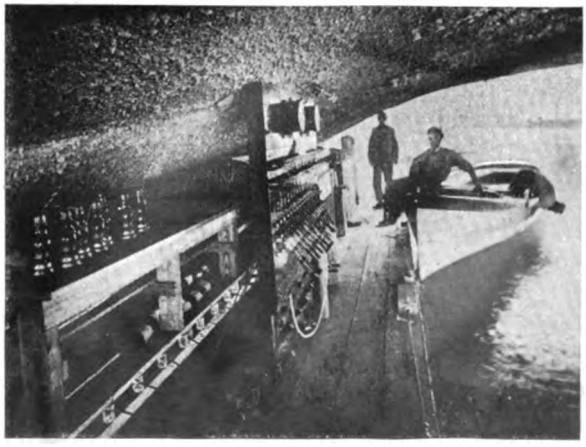
At St. Louis naturally the interest turned at once to the Exposition and the International Electrical Congress. As we arrived but a few hours before the opening of the latter, and during our stay were kept on the go pretty well all the time, few opportunities were afforded for seeing the electrical sights of St. Louis itself. These are, however, of considerable interest, the chief centring in the rapid transit system of the city.

Rapid Transit Systems.

The St. Louis Transit Company takes first place in this respect. It claims the distinction, if there be any, of operating the first horse railway in St. Louis in 1859. It opened a cable railway in 1886, and its first electric line was experimented with in 1887. These initial attempts came to nothing, and not until 1890 was the first trolley-line opened. In 1903 the company were operating 358 miles of track; over this was carried 210.238,108 passengers, and from this traffic has derived gross earnings amounting to £1,451,890. One of the power houses is the Northern Power Station, with a total capacity of 6,900 kw. The chief plant is at the Central Station, which has a capacity of 13,700 kw. These stations furnish both direct and three-phase current. The St. Louis and Urban Railway is another concern, operating a number of street and suburban lines. The East St. Louis and Suburban Railway controls a number of street-car and suburban lines, including 111 miles of track. These afford to numerous outlying districts cheap and efficient transit. To economically generate power a large station has been built in East St. Louis. This furnishes both direct and alternate current for the neighbouring and outlying lines.

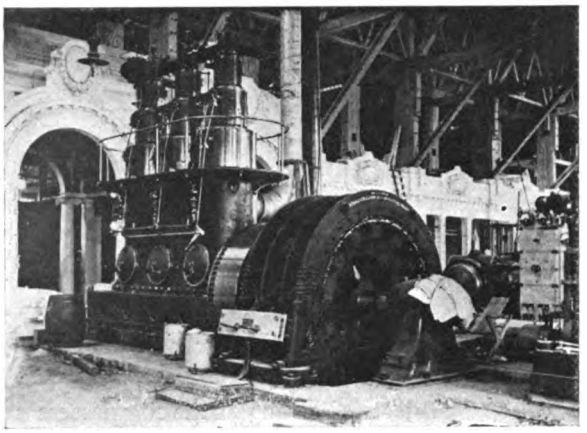
Electric Lighting.

The electric lighting of the city possesses somewhat historic interest. The first plant was installed in 1878, when Carl Heisler brought two small gramme dynamos from Paris. The lamps lighted consisted of Jablochkoff candles. When this service was unsatisfactory the gramme machine was replaced by a Hochhaausen arc machine. The Brush Company followed up this with some extensive street lighting, and since that time numerous companies have sprung up furnishing energy in and around the city. Following the example of other places the mushroom companies have been consolidated and the Union Electric Light and Power Company has now the controlling interest. The Ashley Street plant, which is not quite completed, has been equipped with some 12,000 kw. of plant. In addition to this two 2,000-kw. and four 5,000-



Electric Launches at St. Louis Exhibition.

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WILLANS STANLEY UNIT AT ST. LOUIS EXHIBITION.

kw. turbines are being erected. It is expected that these will come into operation early in 1905. The load at present connected represents 590,000 incandescents, 8,600 arcs, 9,300-h.p. direct-current motors, and 1,000-h.p. alterna e-current motors.

St. Louis was also the scene of the installation of one of the first telephone exchanges in the States, and to-day the Bell Telephone Company is operating a very extensive subscribers' system. It is interesting to note that in connection with this underground system an electric cable drawing automobile is used. The underground system occupies some forty miles of streets and contains some 27,000 miles of wire. This is arranged in cables varying in size from 1 to 480 pairs.

Of the manufacturing concerns the Wagner Electric Manufacturing Company is the largest. This firm exploits a somewhat unique line of single-phase motors and has done considerable business in exploiting these. There are also two large incandescent lamp firms in the city.

PITTSBURG.

PITTSBURG has been appropriately described as "Hell with the lid off." Viewed at night it certainly conveys some such impression. In East Pittsburg, however, are located the chief objects of interest to electrical engineers. Pittsburg is synonymous with Westinghouse, a name which at once recalls the early conflict between direct- and alternate-current methods of electrical distribution. George Westinghouse, with a keen business insight, characteristic of the man, foresaw the possibilities of alternate-current transmission, and purchasing the transformer patents of Gaulard and Gibbs, and the motor patents of Tesla, proceeded to fight the direct-current interest. The Laurenceville test, by which, in 1886, a number of lamps were lighted at the far end of a two-mile transmission line, has now become a matter of history, while the subsequent development on an enormous scale of alternate current apparatus of every description by the Westinghouse Company is equally well known.

The Westinghouse Family.

The Westinghouse Company's operating in Pittsburg, the Machine Company, the Air Brake Company, the Union Switch and Signal Company, the Nernst Lamp Company, and the R. D. Nuttall Company, are all closely allied to the Westinghouse Electric Manufacturing Company. They form the great "Westinghouse Family" so frequently spoken of, and around this they may be said to rotate. We were allotted a whole day to inspect these plants, but as many days as we had hours would have been little enough time in which to examine them in all their details. The Westinghouse Machine Company, which is entrusted with the work of developing the prime mover, has opened its shoulders to its task with a will. Reciprocating engines of all sizes have been made and are operating satisfactorily in some of the world's largest towns. Keeping abreast of the times the development of the steam turbine has been taken in hand and some of the largest types of this machine have been designed and put into operation. The gas-engine, too, has not been forgotten, and both horizontal and vertical types could be seen in every stage of construction in the works. The first direct connected set, gas-engine and dynamo, was operated in the shops of this company, and the total capacity of small machines since manufactured and now in service must be very considerable. The Union Switch and Signal Company have developed a branch

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LECTURE HALL, ELECTRIC CLUB, PITTSBURG.

of business which makes for greater safety in the handling of large volumes of traffic on railway lines, especially at great termini and in goods yards. By combination of electric and air power an automatic system, simple in its essence but elaborate in development, has been worked out. A system of this kind controls the trains on the New York Subway. The chief business of this company, however, is that of displacing the present manually operated systems with an electro-pneumatic interlocking method of the best possible type.

The works of the Nernst Lamp Company came as a revelation to a good many engineers. Over here the Nernst lamp is still too much looked upon as a costly experiment, but one left this factory with a feeling that in proper hands it is something more than a mere laboratory toy. The lamps for the St. Louis Exposition have been manufactured entirely by this Company and number 4,760 glowers. Apart from these, 64,216 lamps of different types have been installed in the United States.

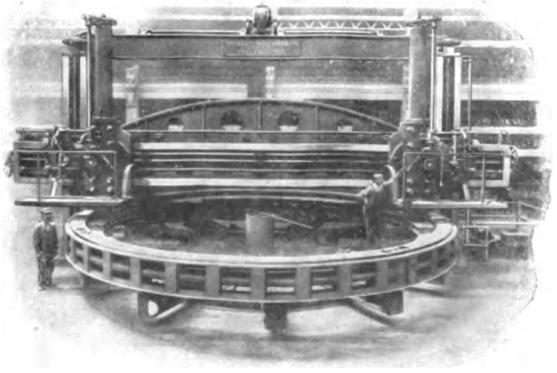
The Westinghouse Electrical Works.

We were all chiefly impressed with the great works of the Westinghouse Electric and Manufacturing Company. These now employ upwards of 9,000 hands and are probably the finest works of their kind in the world. The arrangement of the buildings is strikingly compact, and communication between departments seems to be effected without any difficulty, despite the very extensive nature of the works. The chief products are dynamo electric machinery of every size and description, switch-gear, transformers, and motors of all kinds. The works are operated entirely by polyphase motors aggregating some 5,500 h.p., there being some 250 motors in all. The premium system is in vogue as the basis for all wages. An extensive apprentice scheme is in operation and recently an Electric Club has sprung up which has its own literary organ. There are some 500 members and lectures and discussions of a very useful character are delivered and entered into regularly.

The Steel Works.

The Edgar Thompson steel works contained some genuine surprises in the use of electric power for rail manufacture. Plant once operated through leaky steam-pipes and small engines is now efficiently moved by electro motors, many being specially designed and adapted. Ore is electrically hoisted to the furnace, the metal is poured by motor, and from the time the ingot enters the rail mills it is handled thereafter entirely by electrically actuated agencies.

At the Homestead Steel Works, the creation of Andrew Carnegie, the same



LARGE BORING MILL AT WESTINGHOUSE WORKS.

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displacement of steam by electricity was everywhere evident. Armour plate for battleships is fashioned, the material being open hearth basic steel cast into ingots of 150 tons weight. It is here the skeleton of the skyscraper is formed, and in conjunction with the surrounding steel industries, girders and joists are made for almost every known country.

In the city are many splendid buildings, the gift of Mr. Carnegie, among these being a magnificent Institute bearing his name.

WASHINGTON.

THE capital of the United States could not have been better reserved to figure among the last cities visited. After our rush through great industrial centres Washington came as a pleasing relief with its broad streets, open thoroughfares, and green parks. No effort has been spared to give the city that placid air which every seat of Government should possess, and the place might well be termed the "wireless" city. The trams glide along without the ubiquitous trolley, and as for electric light and power, telephone and telegraph, there might be none. The wires which met the eye constantly in other places have all been put underground, except in a few cases on the outskirts.

The Bureau of Standards.

Our interest centred primarily in the Bureau of Standards. Here some half-hour was spent in inspecting the buildings and their equipments. Organised in 1901 as one of the bureaus of the Treasury Department, it was transferred with certain other bureaus to the newly established department of Labour and Commerce in 1903. The buildings are conveniently situated, having regard to their purpose. They lie about 3½ miles from the Treasury, which is north of Cleveland Park on the highest ground in the vicinity. Complete freedom from vibration of street traffic is assured and magnetic disturbances from neighbouring electric railways are very slight. The buildings are so planned that they can be suitably added to as required. There is a small power house furnishing direct current for lighting purposes and alternate current for experimental work. A number of the machines are specially built for giving a variety of wave forms. There are direct and alternate-current testing laboratories very completely equipped. The bureau comprises three divisions presided over by such eminent men as Prof. S. W. Stratton, Prof. E. B. Rose, and Prof. W. A. Noyes.

Washington Trams.

The story of Washington's efforts to provide its citizens with a tramway system would rival any novel in interest. Forty-two years ago the city made the acquaintance of horse cars, and between that time and the opening of the present conduit system in 1898 confusion reigned supreme. After years of experiment the conduit system was evolved and adopted, and has since been developed over 15½ miles of double track. It also connects with some five miles of track operated with the overhead trolley on the outskirts. Previous to the adoption of electric driving, cable cars had been used, and this circumstance is probably responsible for the replacing of the cable with two conductors in the original conduit.

Like all other American cities Washington can be proud of its telephone system. The main Exchange Building in the centre of the city, recently completed, has a capacity of 10,500 lines.

Power Supply.

The supply of light and power to Washington was originally in the hands of a number of small companies, but these have recently been consolidated as the Potomac Electric Power Company. Their chief power house is full of contrasts. On the same engine-room floor might be seen engines belted to shafting under the floor and driving arc light machines; horizontal engines direct connected to generators, and one of the latest Curtis turbines apparently smiling down upon this long and varied array. Although at present supplying from this somewhat conglomorate system of plant, the company has in view the harnessing of Great Falls some five miles from the city, having acquired the rights and property of the Great Falls Power Company. With this combination of water power and steam, Washington will become an ideal city, both as to lighting and power. At present the company supplies nearly

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all the power necessary for the railway controlled by the Washington Railway and Electric Company.

Government Departments.

Of the numerous Government Departments the printing offices attracted considerable attention. These are equipped entirely with electric power. The printing presses have individual motors and electric heaters, for the many varied accessory processes to printing are in constant use. Although the installation was begun in a parsimonious and conservative way, subsequent developments point to a complete realisation on the part of the officials of the advantages of electric light, heat, and power, and extensions on a generous scale have been carried out.

Electricity is being very widely used on the United States battleships both for the usual purposes of illumination and as power for moving guns, ammunition hoists, wireless, &c. In the army there are telegraph and telephone corps, and wireless telegraphy is also being extensively adopted.

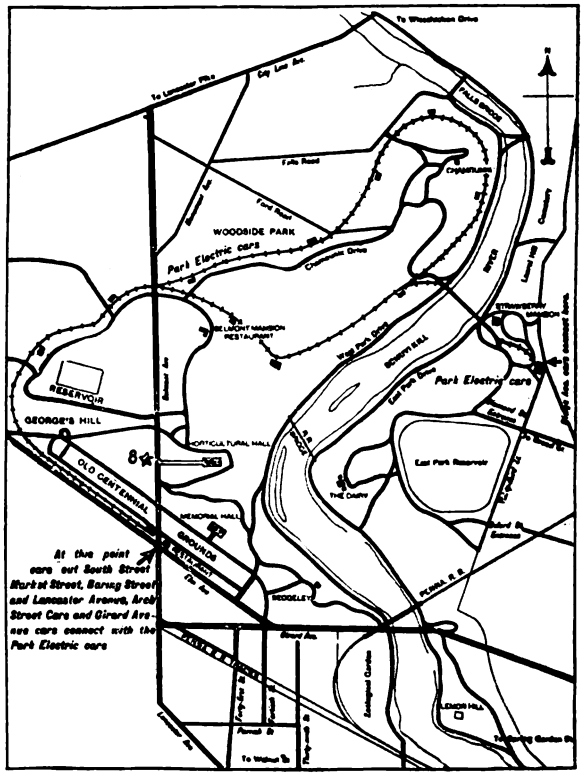
PHILADELPHIA.

APPROACHING Philadelphia we remembered that it ranks as third in population in the United States and is one of the nine greatest cities of the world; that it was really born in 1682, is fifteen miles long by seven wide and that no other city contains as much space *per capita*.

Philadelphia is the centre of numerous and varied industries. Engineering is well represented by the great Baldwin Locomotive Works, and we were conducted through a part of these. Although builders of steam locomotives chiefly, quite a deal of work is done with electric locomotives. By an arrangement with the Westinghouse Company the works construct the framework and trucks and the Westinghouse people supply the motors and controlling gear. The tools are electrically operated and many splendid examples of individually driven tools came in for a full share of inspection. Among these were specially noticed a double-headed frame slotting-machine, a special tool upon which four locomotive frames each five inches thick can be operated at one time.

Power Supply Plants.

In the matter of power stations Philadelphia is in no way behind the times. Its present company, the Philadelphia Electric Company, has amalgamated the interests and systems of twenty-seven different companies. This has proved no mean task, but concentration has been effected in two large power houses furnishing alternate and direct-current respectively. The former is by far the more interesting. The plant comprises boiler and engine house, the last mentioned having a number of mezzanine floors to accommodate the switch-gear. It was decided to instal the largest units procurable, and plant of a similar design to that operating the New York Subway is being introduced. Two-phase 6,000 volt current is furnished



FAIRMOUNT PARK, PHILADELPHIA.

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to about 13,700 consumers. There are also several plants operated by the United Gas Improvement Company.

A Great Tramway System.

The Philadelphia Rapid Transit Company operates one of the finest traction systems we were privileged to inspect. At present some 550 miles of track are laid, and upon this 1,600 odd cars are constantly running, carrying in the aggregate 1,100,000 people daily. The annual receipts total about £3,200,000, and from these figures the magnitude of the undertaking can be understood. The well-known American plan adopted by tramway concerns of purchasing land and laying it out in parks on the outskirts as an inducement to traffic has been developed on an extensive scale. At Willow Grove one of the finest of these pleasure grounds has been laid out, in which there is an electric fountain which is said to have cost one million dollars.

The company is developing an extensive scheme of elevated and subway traction which will give Philadelphia transit facilities unequalled by any other city of its size in the world. Incidentally we may remark that about 10,000 men are in the company's service. Power is supplied from generating stations having a capacity of 43,150 kw., backed up by storage batteries of 5,200 ampere capacity per hour. We hear much in this country of the beneficial effects of transit facilities in raising the tone of the suburbs of a large town, and from the records available Philadelphia is a splendid example of what can be done in this way.

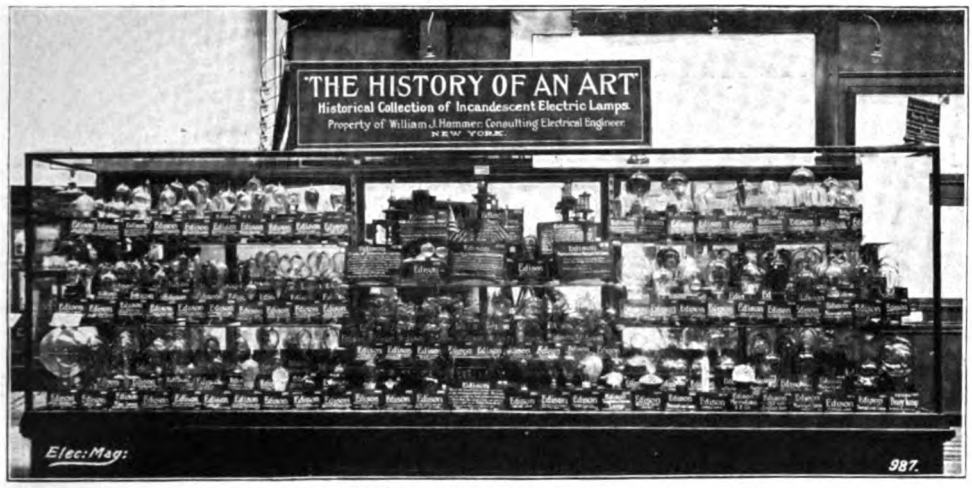
"EDISONIA."

On the conclusion of the official Tour at Philadelphia most of the party with a number of American electricians accepted the invitation of Mr. Thomas Alva Edison to visit his laboratories at West Orange, on Thursday, September 22. The visit was much enjoyed, and Mr. Edison personally conducted the party through the various laboratories. This seems a fitting point at which to make brief reference to the collection of "Edisonia" exhibited at St. Louis by the Association of Edison Illuminating Companies. This occupied some 3,000 square feet of Section C in the Palace of Electricity. There was a reception room for members and also a retiring-room and office.

An Historic Exhibit.

The collection was of great historic interest and was inspected by many electricians with mixed feelings of surprise and admiration. In all some sixteen pieces of electrical apparatus, thirty-two large photographs of apparatus and power houses, twelve photographs of machinery at Ogdensburg Ore Mills and a historical collection of incandescent electric lamps were on view. The original Edison "Jumbo" dynamo and engine was loaned by the New York Edison Company and presented a curious contrast to the more modern machinery in the building. This machine was first made in 1881, but only after surmounting some of the most discouraging obstacles. It was exhibited at the Paris Exhibition of 1881, and its appearance there was hailed by scientists and engineers as a most noteworthy event. Its total weight is thirty tons and it has an output of about 50 kw. when run at 350 r.p.m. The engine is horizontal without fly-wheel and built by Armington and Sims. About twenty-four of these machines were made and put into active service. Among the other interesting exhibits was a model of the old Pearl Street Station, New York, the first permanent commercial incandescent lighting and power station. The plant consisted of Babcock and Wilcox boilers and six Jumbo generators. There were four floors, the boilers being at the bottom and directly above them were the generators; in the two upper floors wore a storage battery and the regulating apparatus. When this station was first started there was not a single electrical instrument in it! Pressure was regulated according to the indications of red and blue lamps put in circuit by an electromagnetic device. The station, although presumably fire-proof, was burned down in 1890 and this catastrophe caused the only serious interruption in the supply of the New York Edison system which has ever occurred. The story of the making of the first electric lamp is pregnant with interest and might well form subject-matter for a substantial volume. However, a large case, containing the various

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EDISONIA HISTORICAL COLLECTION OF ELECTRIC LAMPS.

lamps made, forming part of the exhibit, was a history in itself This collection reflects creditably on the faithful efforts of Mr. W. J. Hammer, who conducted the early experiments with Mr. Edison, to put on record the various stages of so epoch-making a task. The collection of lamps represents the work of twenty-five years. Another very striking object was Edison's first electric locomotive and trailer, built and operated in 1880 at Menlo Park (*see* Electrical Exhibits section, p. 141). In examining this one hardly realised that it was the first parent of so noble a line of descendants. By the auspices of the Association of Edison Illuminating Companies a handy guide, noteworthy of the exhibit, had been prepared, and appropriately dubbed "Edisonia." Those fortunate enough to procure this volume have become possessed of information and data which is not to be found between the covers of any other publication. To even epitomise its contents would occupy more space than we could hope to give, but it is an extraordinary record of the untiring labours of a devoted band of scientists, under the indomitable leadership of a great genius.

Alphabetical List of Members on the Circular Tour.

E. AMBROSANO
B. J. ARNOLD
PROF. M. ASCOLI
L. ASCOLI
A. F. T. ATCHISON
G. BALFOUR
R. S. BALL
F. E. BARKER
W. A. BARNES
G. BAROSI
C. BARZANO
D. BATES
MRS. BATES
G. C. BLAIR
C. V. BRAZZOLA
G. BULLOCK
A. CARELLI
F. CARINI
N. CASTELLINI
F. CAVALIERI
W. J. CLARK
J. T. CONNOLLY
MRS. CONNOLLY
PROF. J. D. CORMACK
MRS. CORMACK
COL. R. E. CROMPTON
C. A. CURTI
F. DANIONI
E. G. DENNISON
J. R. DICK
A. DOW
W. DUDDELL
J. EDGAR
J. S. EDSTRÖM
E. EGGER
C. EKSTRAND
R. S. ERSKINE
MRS. ERSKINE
PROF. G. FANO
T. FEILDEN
J. A. FOSTER
L. GALIMBERTI
E. GAMBA
W. GEIPEL
G. T. GIORGETTI
F. GIUDICE
DR. R. T. GLAZEBROOK
A. GONZALEZ
P. G. GOSSLER
C. B. GRAHAM
R. K. GRAY
F. E. GRIPPER
G. G. GROWER
R. HAMMOND
MISS HAMMOND
H. E. HARRISON
C. C. HAWKINS
M. HAYASHI
J. C. HAYS
T. HESKETH
MRS. HESKETH
F. HOPE-JONES
W. S. HOWELL
C. W. HUTTON
M. JENNISON
E. JONA
W. H. KERNOT
F. C. KIDMAN
F. KLOECKNER
H. LEISSE
H. W. LEONARD
MRS. LEONARD
J. W. LIEB (JUN.)
MRS. LIEB
E. H. LIEBERT
G. C. LLOYD
PROF. L. LOMBARDI
F. M. LONG
B. LONGBOTTOM
PROF. F. LORI
A. MAFFEZZINI
R. S. MCLEOD
S. MAGRINI
J. MARSHALL
R. B. MATTHEWS
J. T. MARR
W. B. MARR
F. O. MILLS
W. E. MOORE
D. K. MORRIS
J. T. MORRIS
L. G. E. MORSE
E. H. MULLIN
MRS. MULLIN
F. H. NALDER
G. NEWBURY
A. ODAZIO
M. OTAMENDI
A. PANCALDI
R. B. PERRING
PROF. J. PERRY
MISS A. M. PERRY
A. PRESENTI
A. PICCHI
A. PIRELLI
L. PIZZI
R. W. POPE
W. G. T. POPE
MRS. POPE
E. PRANDONI
A. PRUCKER
A. P. PYNE
C. W. RICE
MRS. RICE
E. RIETI
G. H. C. RISCH
G. ROBBO
A. RUBINI
C. A. SCHAEFER
E. B. SCHATTNER
C. F. SCOTT
E. K. SCOTT
W. H. SCOTT
E. H. SEAMAN
A. B. SEE
MRS. SEE
MASTER SEE
U. SEGRE
A. SILVA
C. H. SHARP
P. S. SHEARDOWN
G. SNOLCK
T. SORAGNI
F. J. SPRAGUE
MRS. SPRAGUE
MISS A. STOWER
G. STRAMEZZI
G. STUCKY
W. SUMMERSCALES
C. D. TAITE
M. J. E. TILNEY
P. TORCHIO
MRS. TORCHIO
G. TOSI
C. TOWNLEY
R. TREE
A. VENZAGHI
A. G. F. WEBB
H. G. WHITING
G. WILKINSON
R. F. WILLIS
MRS. WILLIS
E. B. WOOLLAN
A. ZELEWSKY

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EXHIBITS OF ELECTRICAL MACHINERY AND APPARATUS.

The Exposition and the Palace of Electricity.



THE electrical engineer on entering the Exposition Grounds would naturally make his way towards the Palace of Electricity. But before reaching it his attention would be attracted by numerous objects *en route*. Still, to have gone round the various buildings and inspected their contents within the limits of time left to us between Congress Meetings and the hour of departure would have been impossible. The grounds were only reached after a car ride of several miles, and by nothing short of a continuous hustle was one able to see anything. Many beautiful buildings and delightful spots remained unentered and unvisited notwithstanding. Only a casual glance was possible at objects really demanding close scrutiny, and with a friendly handshake here, or a chat on the telephone there, one "did" the round of the electrical exhibits. An official reminder was needed of the object of the Exposition, and reference to the Guide Book informed one that it was the third great International Exhibition held in the United States, and that each of these illustrated a sentiment. At Philadelphia, in 1876, was celebrated the Centennial of the Declaration of Independence; at Chicago, 1893, was commemorated the four hundredth anniversary of the discovery of America by Columbus: while the third, and the object of our visit, recognised the Centenary of the acquisition from Napoleon in 1803-4 of the great territory then known as Louisiana. The amount paid "The Little General" (£3,000,000) is scarcely one-third of the sum spent on the buildings and grounds of the Exposition. In response to the popular demand for recognition of this event a movement culminating in the "show" of last year was set on foot in 1898 at a meeting of the Missouri Historical Society. Since then varying sums were granted by Congress, the City of St. Louis, and different States and foreign Governments towards the Exposition, and about as much time intervened for the spending of the amount collected as was consumed in raising it. The following table giving statistics of previous exhibitions is of interest.

	Size. Acres.	Area under Roof. Acres.	Illumination. Electric Lights.	Cost.
St. Louis, 1904 .	1 263	300	210 000	$ 0.000,000
Chicago, 1893 .	633	194	102 000	28,000 000
Paris, 1900 . .	336	117	76,720	22,000 000
Buffalo, 1901 . .	300	15	—	6,000,000
Philadelphia, 1876	236	62	—	—

The site of the Exposition measured two miles by four miles and chiefly comprised virgin forest on heavy rolling land. Wide clearances were made, and since December 1902, when operations commenced, the entire tract had been metamorphosed. Valleys had been filled and hills made low; and upon the new expanse the buildings had arisen. Grouped to form an enormous fan, the chief structures radiated from Festival Hall and the Colonnade of States—the handle of the fan—an architectural masterpiece by Cass Gilbert. The Palaces of Electricity, Varied Industries, Manufactures, Education, Mines and Metallurgy, Liberal Arts, Machinery and Transportation made up the "spread" of the fan, and the first two were surrounded by the waters of the great lagoon. Festival Hall, at the head of the Grand Basin, crowned a broad terrace, studded with fountains, which, with a supplementary supply, fed the cascades stretching away from the crest of the hill. Viewed at night, when the buildings were ablaze with electric lamps and coloured lights played on the water, the scene was one of unparalleled beauty and surpassing charm.

The following brief account of the exhibits includes only the largest and

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MINES AND METALLURGY BUILDING.

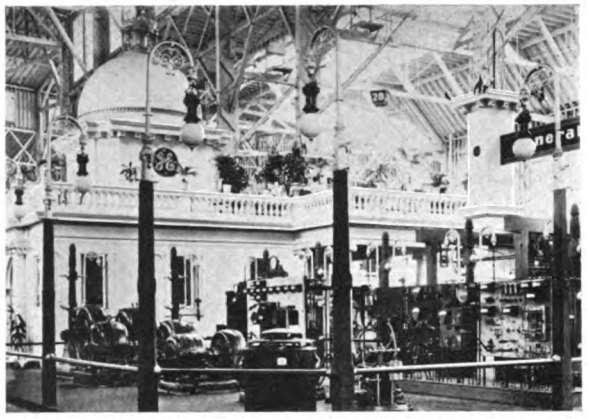
most imposing shows, as these typified the most recent electrical developments. Since standards of machinery and apparatus have come into vogue the production of any really startling inventions has been minimised somewhat. Some electrical engineers were rather disappointed in the exhibits, but having regard to the above factor there was nothing to justify such a feeling.

The Exhibits.

The General Electric Company.

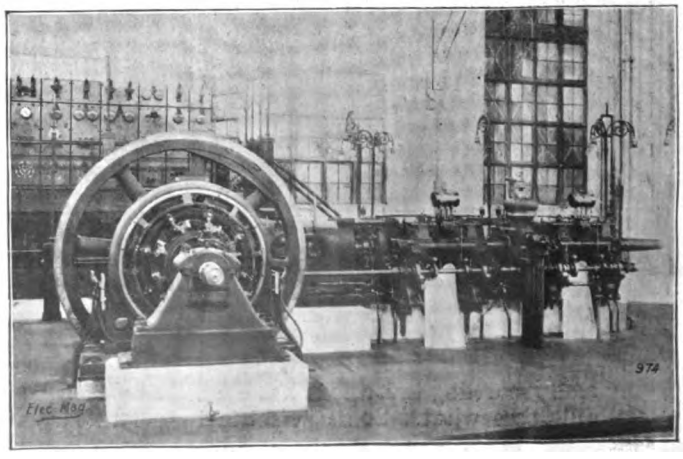
THE largest individual exhibit was that of the General Electric Company, which occupied a quarter of an acre of floor

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A Corner of the General Electric Exhibit.

space. In this a great variety of the Company's manufactures was assembled, and quite a large number were shown in operation. The exhibits had been very carefully selected and included many representative types of electrical apparatus. A prominent feature was a full-sized model of the 10,000-h.p. vertical shaft generator as built for the Canadian Niagara Falls Power Plant. This rested on a concrete base, and underneath it was a small room containing a number of photographs of the Company's Niagara Installations. The room was artificially lighted by examples of the Company's different types of lamp, the "Meridian" Incandescent, the enclosed Arc, and the Mercury Vapour lamp. The latter were exhibited for the first time, and the central tower on the stand was crowned with a cluster of them. They take 3½ amperes each on a 1.25 volt direct-current circuit. The new magnetite Arc lamp was also on view. Needless to say there was a full-size car equipped with a Sprague General Electric multiple unit control system. There was a special attraction for mining engineers in the shape of a seven-ton locomotive, fitted with a self-winding cable reel which takes up its own slack. The cable drum contains 700 ft. of cable. A 60,000-volt electrically operated three-phase switch was another interesting piece of apparatus, as was also a 2,333-kw. transformer built to operate on a 55,000-volt transmission circuit. There was a good showing of motors and motor-driven tools, and not the least interesting of motor applications was a large 24-in. valve operated by a small motor. Space was also given to a Mercury Vapour rectifier with a capacity of 10 amperes direct current. This was appropriately shown side by side with a motor generator set of equal output. The rectifier was supplied with single-phase current at one pair of terminals, and delivered direct current at another pair, the efficiency being 75 per cent. The direct current obtained was used for operating a 7½-h.p. motor. A large collection of measuring instruments was shown, among these being some new curve drawing wattmeters and volt meters. The well-known Thomson pre-payment wattmeter was also on view. The General Electric series alternating arc systems found practical exemplification in the lighting of the exhibit, there being some twenty-five lamps supplied by a constant current transformer. This system was also used for lighting the exterior of the Exposition buildings, the Pike, and outlined portions of the grounds.



Westinghouse Horizontal Gas-Engine and Generator.

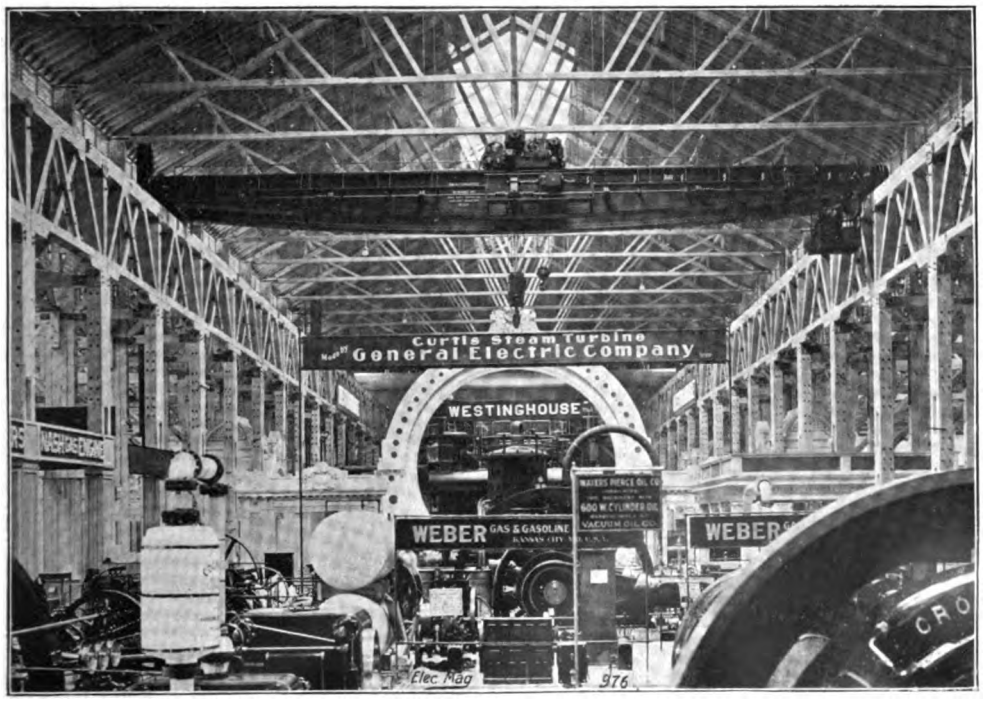
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The Westinghouse Company.

The Westinghouse Companies were greatly in evidence in the Palace of Electricity, and occupied much space devoted to various apparatus. In addition to the Service Plant in Machinery Hall there were many large working examples of Westinghouse plant and machinery. The particulars given below apply to the most important of the machines shown.

With field and armature mounted separately for the better display of its characteristic features, a 400-kw. generator of the turbine type was of great interest. The winding is proportioned for a potential of 440 volts, three-phase, 50 cycles per minute, and a running speed of 3,600-r. p.m. The armature is stationary. The revolving field was a departure from the construction of earlier machines. At a speed of 3,600 r.p.m., centrifugal strains are somewhat heavy, and rendered the usual laminated construction impractical. Accordingly, the field is formed of a cylinder of solid steel milled out to form the poles and to receive the hand-wound coils which are embedded in deep slots and securely held in place by wedges.

The new type self-contained alternating current generators recently developed by the Company were exhibited for the first time. Three units were on view, rated respectively at 75, 100, and 150 kw. The 75-kw. generator was erected in the operating sub-station and direct coupled to a direct current type S motor, forming a motor-generator set which supplied the alternating-current arc light system. The other machines were arranged for belt connection and constructed with eight poles, and operated at a speed of 900 r.p.m.



GENERAL VIEW OF AISLE IN MACHINERY HALL (ENTRANCE TO WESTINGHOUSE SERVICE PLANT IN BACKGROUND).

We understand that a complete line of these generators, wound for any commercial potential, 6,600 volts or below, and two or three phase, has been developed.

Probably no feature in the electrical exhibits attracted so much attention as the single-phase railway motor. Motors of this type were exhibited for the first time outside the works of the Westinghouse Company. That they were mounted upon a standard

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truck and shown in operation added greatly to the interest and offered a clearer demonstration of their practicability and success. The motors shown were of the straight series type with commutators, and rated at 75 h.p. The field of each consists of a cast-steel frame enclosing a laminated core made up of ring-shaped punchings of soft steel.

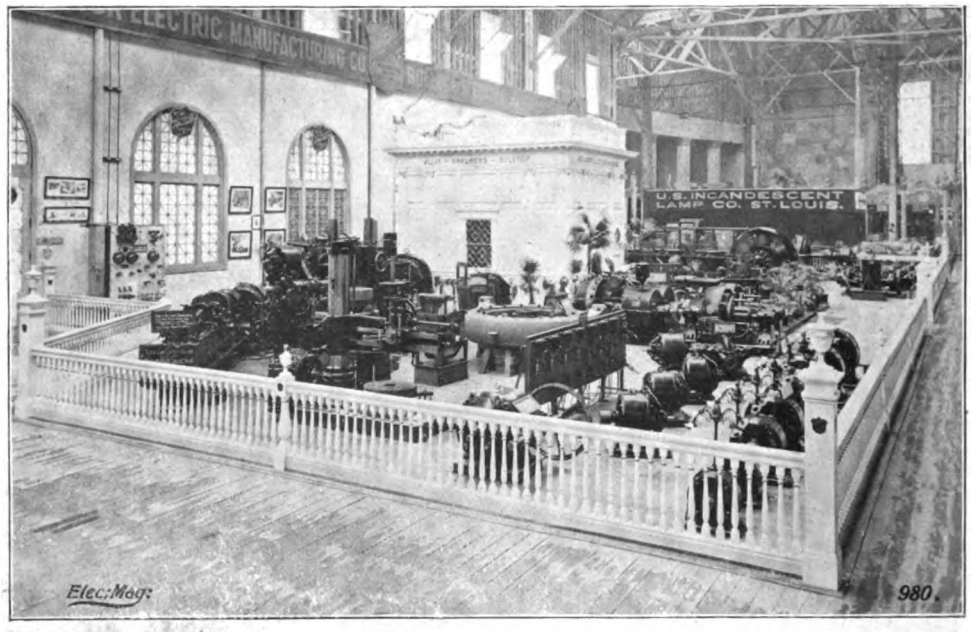
The direct-current railway motor exhibit was also very complete, comprising ten motors of different types and ratings.

Another interesting feature was the new system of car control which is being used on the new electrified Metropolitan lines in London. To many engineers the Exposition brought the first opportunity of seeing the system in operation. The working parts of the apparatus had been mounted on a pyramidal frame of wood, and were so arranged that every detail could be closely studied.

A large show of direct- and alternate-current motors was made. The latter especially have become world famous, and a double interest attached to them, as the Westinghouse Company first championed the cause of polyphase working in America, and piloted it to success through every kind of opposition.

The Bullock Electric Manufacturing Co.

This exhibit at the World's Fair represented the highest developments reached in the manufacture of electrical apparatus. In the Electricity Building a large space had been secured, in the centre of which was an ornamental pavilion, handsomely and comfortably furnished. The practical

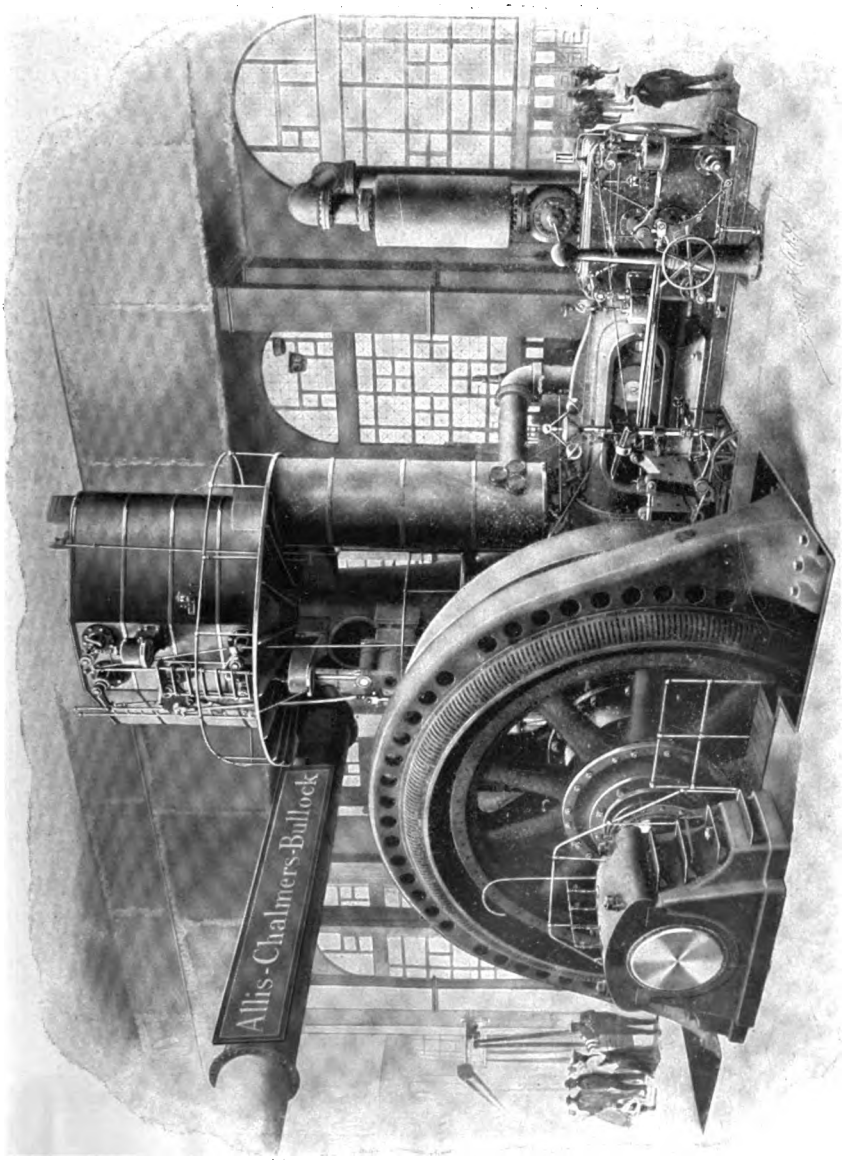


BULLOCK ELECTRIC MANUFACTURING COMPANY'S STAND.

operation of the now famous Bullock multiple voltage system was shown by a complete outfit. This included the main generator furnishing current at 250 volts and a balancer dividing the voltage into 90 and 160 volts. An engine lathe, a milling machine, a boring mill and a shaper, all direct driven by Bullock type "N" motors, were operated by this set.

The five alternating-current generators on exhibition ranged in size from 50 to 350 kw. We were told that the Company is prepared to build alternators up to 10,000 kw. The 100-kw. synchronous motor generating set on view has proved singularly successful in service. A large number of these have been installed, all operating on water and steam power

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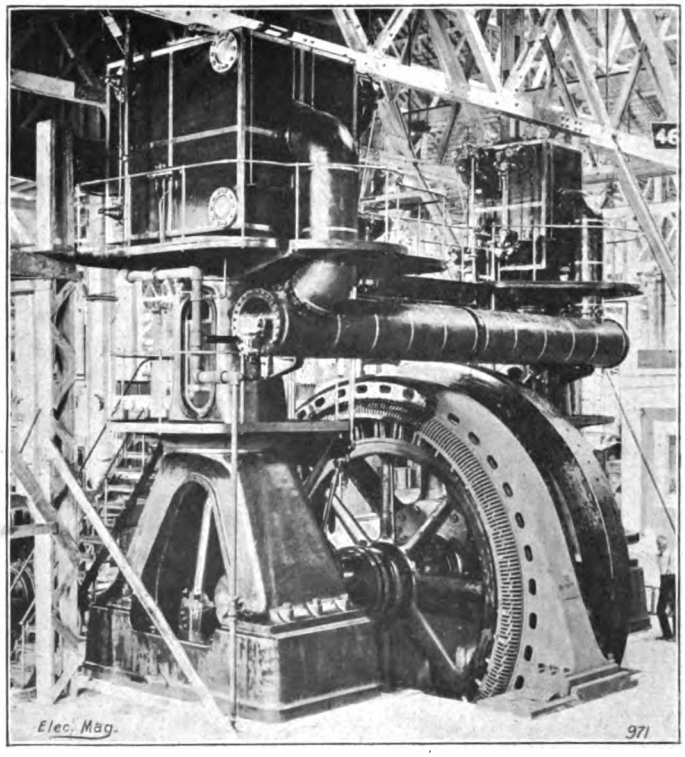


The Big Reliable.

Allis-Chalmers-Bullock 5,500 h.p. Unit in Machinery Hall operating the Illuminations in the Grounds.

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plants without hunting. These sets were provided with oscillators of a patent design which prevent the formation of grooves on the commutator, thus greatly prolonging its life. It also ensures cool operation of the bearings. The street car exhibit included two heavy trucks, on each of which were mounted two 50-h.p. Bullock street car motors. The yokes of these motors are designed in a very ingenious manner to afford the maximum amount of ventilation, and prevent the entrance of dirt or dust. A distinctive feature in the design of these motors is the ease of inspection and facility for making repairs.



1,500 KW. ENGINE-DRIVEN UNIT OF NATIONAL ELECTRIC COMPANY.

The largest power unit in the Exposition was a 3,500-kw. engine type 3-phase alternator, above referred to, furnishing current at 6,600 volts, 25 cycles, and running at 75 r.p.m. The generator was driven by a 5,500-h.p. single crank compound engine built by the Allis-Chalmers Company of Milwaukee, Wisconsin. The height of this engine including its base was 54 ft., and the overall dimensions of the complete unit approximately 35 × 45 ft. The total weight was over 500 tons. The combination went under the appropriate cognomen of "The Big Reliable." The set was given an exhaustive test, and accepted by the Exposition officials without any change before the opening day of the Fair.

The generator is of the revolving field type. The stator yoke is cast in four sections, securely fastened together by body bound bolts and held in proper alignment by square splines. These bolts are on the inside of the yoke, which eliminates the necessity of projecting lugs and gave the machine a graceful and pleasing outline. The stator casting is so cored as to admit an abundance of fresh air for ventilation through the suction effect of the rotor when in motion. The yoke is 27 ft. in diameter, the overall dimensions being 33 ft., and the casting alone weighs 58,000 lbs. The stator core is built up of mild annealed steel discs fourteen mils. thick, carefully japanned to reduce the eddy currents and again annealed after punching.

The National Electric Company.

Among the important exhibits in the Electricity Building was that of the National Electric Co., Milwaukee. There was in this space a fine exhibit of air-brake equipment as well as electrical machinery, this Company being the successor to the Christensen Engineering Co. The exhibit included a 150-kw. direct-current generator driven by a 20-h.p. 220 volt motor, a 150-kw. alternator of 3,200 volts, and a 10-kw. motor generator set.

The National 1,500-kw. 6,600 volt, 3-phase, 25 cycle alternator was in operation at 85 r.p.m. This generator was direct connected to a 2,250-h.p. compound

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vertical engine, and the entire machine represented one of the most modern generating units. This machine furnished power to operate the immense streams of water for the cascades, the largest artificial waterfalls in the world.

Crocker-Wheeler Company.

The exhibit of the Crocker-Wheeler Co. and the Lane and Bodley Co. included an 800 h.p. cross compound condensing heavy duty engine of the horizontal type directly coupled to a 600-kw. generator of the Crocker-Wheeler railway type, this unit being utilised with six others for operating the Intramural electric railway. The engine had a fly-wheel 18 ft. in diameter, made in halves and weighing 30 tons. The valve gear was of the double eccentric type, having direct straight line connections between the eccentric rod and the valve, and avoiding the use of the wrist plate common to Corliss engines.

The remaining six generators for the Intramural line were all Crocker-Wheeler machines and ranged in output from 100 to 900 kw. The prime movers comprised horizontal and vertical steam engines by various makers, and a water-wheel operating under 300 lbs. pressure.

Crocker-Wheeler motors were also in operation driving machine tools in various parts of the Exhibition.

The Automatic Electric Company.

One entered the exhibit of the automatic telephone sceptical and cynical, but after an inspection of the system, and an optical demonstration of its capabilities, these feelings give way to admiration and conviction. The Automatic Electric Company operates the Strowger patents of automatic telephony, and if its contracts are any criterion it is exploiting a good thing. We were much struck with the ease a connection to any subscriber's number could be made, and even on a large board the selection of the desired station was quick and accurate. The

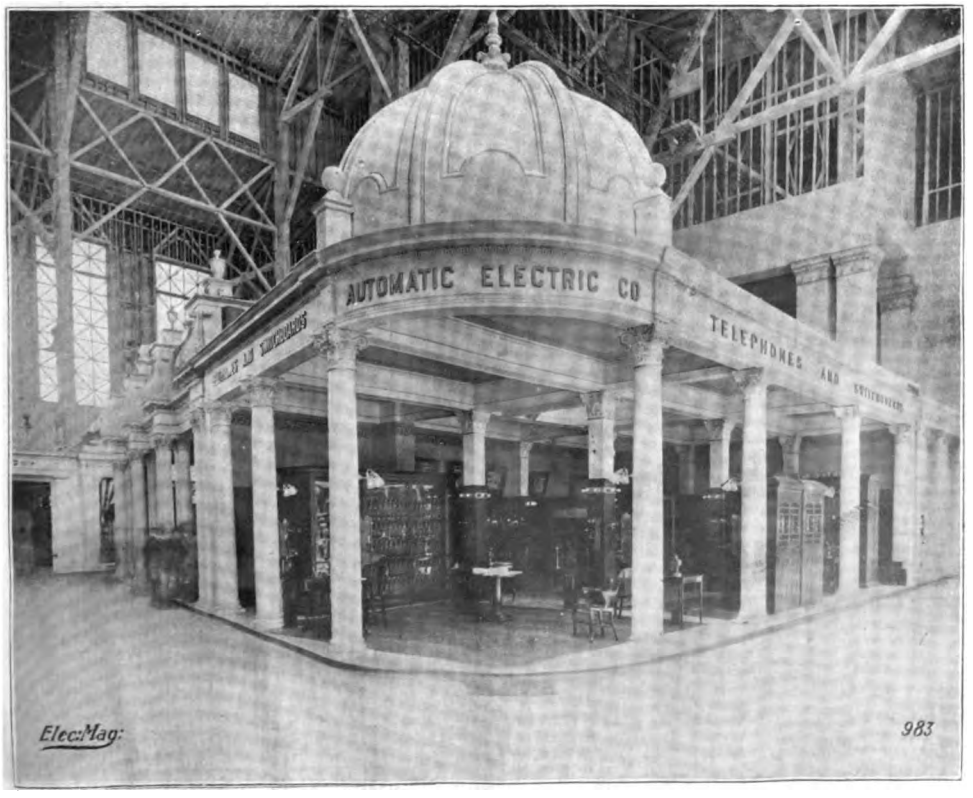
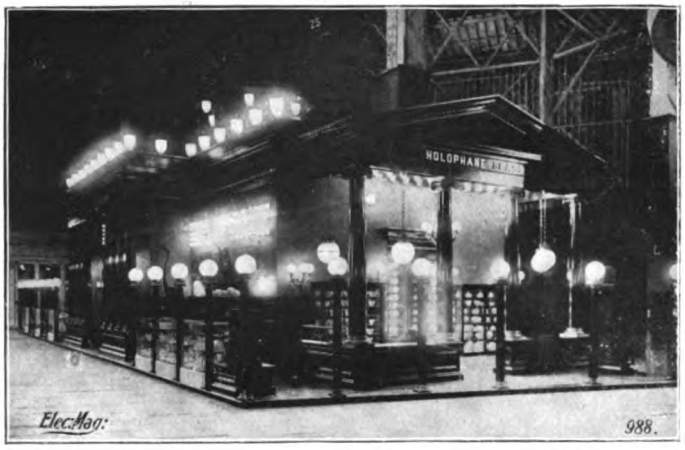


EXHIBIT OF THE AUTOMATIC ELECTRIC COMPANY, SHOWING AUTOMATIC TELEPHONE SYSTEMS.

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Holophane Exhibit Illuminated.

system was not confined to the exhibit, but of the fifty lines connected half were scattered about the building and therefore in constant service.

The Holophane Glass Company.

The problem of diffusing light artificially and economically has always been a fascinating one. The difficulties surrounding its accomplishment have proved of no mean order, but judging by the display of the Holophane Glass Company they have been successfully surmounted. Practical example of the Company's contention for the efficiency of its system was made on its extensive and elaborate stand. The comparison was effectively made by illuminating the two halves of a furnished room by lamps equal in number and disposition but with and without Holophane shades. The difference was sufficiently marked to be startling. We were told that some recent tests at New York Electrical Testing Laboratories on shades taken from the Astor Hotel and Holophane reflectors, showed differences of from 16 to 58 candle-power in favour of the latter. Results of this kind in improving illumination are of course secured without extra consumption of current.

X-Ray Exhibit.

Everything connected with X-Ray work was to be found at the stand of Emil Gundelach, of Gehlberg, Thuringia, in the Educational Building. He had provided a special dark room with apparatus in operation, demonstrating in particular the electric discharge in air-rarified chambers. At the bottom of the cabinet there was an electrical induction apparatus, while the upper part contained twelve various air rarified glass apparatus, some of which were shown in operation.

A most interesting and novel bouquet was made of metal flowers, the leaves and blossoms of which are painted with different radio-active substances. A pair of radiometer wings painted with the American colours were turning above the flowers, and were intended to show the mechanical effect of the electric discharge. Other devices were shown to exhibit the heat effect.

Western Electric Company.

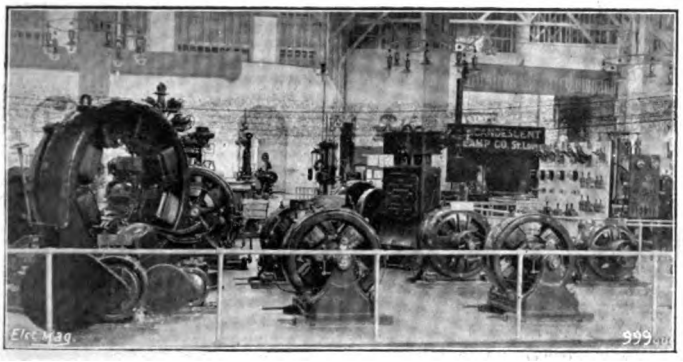
One of the most interesting exhibits of modern electrical apparatus was to be found in Space 17, near the south-west corner of the Electricity Building, and occupied by the Western Electric Company of Chicago, New York, and London. For the visitor's convenience their space was divided by aisles into five parts, in each of which apparatus, pertaining to some particular branch of the lighting or power business, was on view. A large motor generator was first noticeable, the motor part of this set taking current from the 500-volt power circuit of the Exposition Company. The generator delivered current at 220-volts to the distributing switchboard located nearby.

This motor generator operated in conjunction with a compensator, so that



Exhibit of X-ray Tubes.

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WESTERN ELECTRIC COMPANY'S STAND.

current of 110 and 220 volts was available for distribution, with the result that from this unit, power motors, fan motors, arc and incandescent lamps of 110 and 220 volts were operated in different parts of the exhibit. The compensator set consisted of two 125 volt or 250 volt compound wound machines, connected in series across the main wires, having a potential of 250 volts or 500 volts.

Wagner Electric Manufacturing Company.

The most important display of the electrical manufacturing interests of the City of St. Louis was that of the Wagner Electric Manufacturing Company. This Company is an organisation limiting its manufacture to a number of specialties such as single-phase motors, static transformers, direct-current power motors and generators, motor generator sets and indicating switchboard instruments.

In the space occupied by this Company were displayed a large variety of applications of single-phase motors, this being in effect the chief feature of the display. The use of single-phase distribution in American central stations has resulted in their very wide adoption of the single-phase motor. The Company's transformer display included illustrative units varying from 6-kw. capacity to 500 kw. The instrument exhibit comprised a switchboard with examples of the various forms of instruments mounted thereon.

Foreign Electrical Exhibits.

Great Britain.

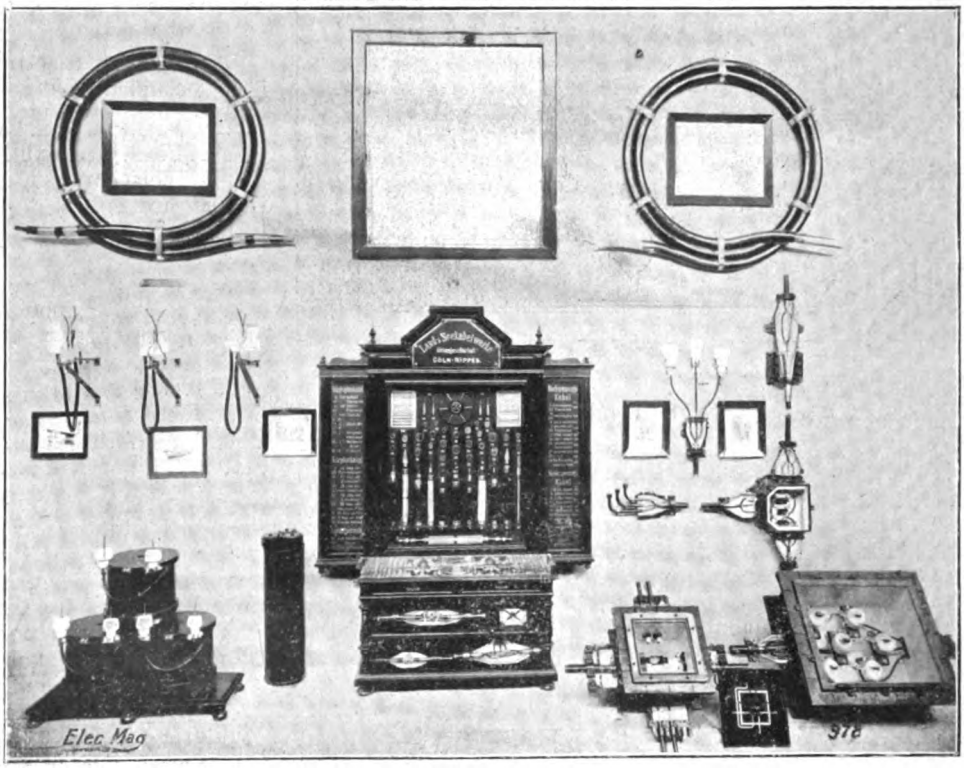
THE British Exhibits like the German contained no heavy machinery, being confined almost entirely to instruments. A fair space to the right of the main entrance to the Palace of Electricity was occupied. We can do little more than reiterate the names of exhibitors and their apparatus, as they are all very well known to British engineers.

Messrs. Crompton and Co. made a good show with potentiometers, Wheatstone bridge and a number of galvanometers and manganin resistances. Elliott Bros. showed double astatic voltmeters, galvanometers, Wheatstone bridge and low resistance potentiometers. There was also a portable wattmeter, several multiple range current transformers and other instruments. Nalder Bros. and Co. had thirty-six instruments on view, among which were an Ayrton and Mather resistance box, a secohmeter and a Hopkinson permeameter. Kelvin and James



EXHIBIT OF WESTON INSTRUMENT COMPANY.

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CABLE EXHIBIT OF LAND UND SEEKABELWERKE.

White, Ltd., showed a class of instrument for which they have become famous, and seemed to be unique as the only makers — the electric balance. Messrs. Everett and Edgcombe made a fine display of their well-known instruments. A special attraction was their new "inkless" recorder which has the obvious advantages of absence of friction between pen and paper, no ink to clog the pen or dry up, and as a crowning feature possesses a special clock which requires no winding. The other instruments included a rotary synchroniser for which the firm has obtained a considerable reputation, a three-phase power factor indicator and an indicating wattmeter. There were also on view a glow lamp photometer and a new form of Wheatstone bridge which is direct reading and is complete with standard resistance and d'Arsonval galvanometer.

The Cambridge Scientific Co. were to the fore with their famous oscillograph, and, in addition, exposed several resistance thermometers, a Callendar electric recorder and standard resistance.

The India Rubber, Gutta Percha and Telegraph Works Co., Ltd., showed some fine examples of submarine cables. For this class of cables the Company has a reputation unequalled in the world, and the samples on view, though unostentatious enough in themselves, will probably have impressed American engineers with the stability of the telegraph cable industry in this country. It was whispered at one time that telegraph cables could not be made outside Great Britain, and the Silvertown exhibit will doubtless have done much to confirm this view.

Other British exhibitors were the Consolidated Electrical Co., Ltd., Sherard Cowper-Coles, Ltd., A. C. Cossor, Darton and Co., General Post Office, Muirhead and Co., Nalder Bros. and Thompson, R. W. Paul, and the Synchronome Co.

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Germany.

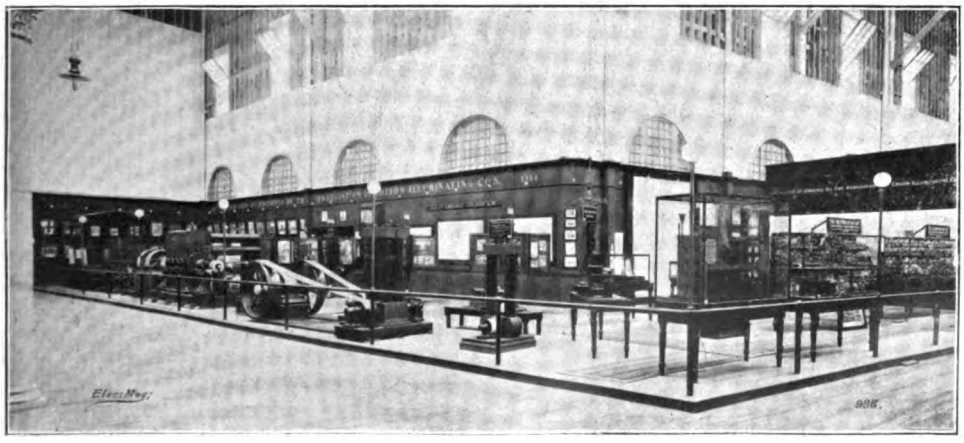
The German section contained none of that heavy electrical apparatus for which German engineers have established so enviable a reputation.

Messrs. Siemens and Halske, who made the largest exhibit, divided their apparatus into four groups: first, measuring equipments; secondly, typical measuring instruments; thirdly, switchboard instruments of all kinds, and lastly apparatus for the transmission of the movement of the compass needle. In the first group we noticed a very neat compensation device for the exact measurement of current, and voltage by the compensation method of Poggendorf and Dubois-Reymond. In the same group were shown the necessary methods for determining induction and the loss of energy in alternate-current apparatus. A precision standard of inductance was also shown, this being based on the theory of M. Wein. The apparatus for the testing of the magnetic qualities of iron and steel in samples of certain size and form was of considerable interest. A Blondell Oscillograph was also exhibited, a number of improvements having been effected by Siemens and Halske.

In the second group was a fine collection of precision instruments for direct current, among which was a universal galvanometer, which was a combination of the Deprez-d'Arsonval instrument and a Wheatstone bridge. An induction instrument on the Ferraris principle recently marketed for the measurement of alternate current was also shown.

The third group containing switchboard instruments comprised a panel upon which was a splendid collection of recording instruments of different kinds and their accessories. Among the recording instruments was one in which a spark punctures the paper and momentarily records the value of current voltage, &c.

The fourth and last group was especially interesting, comprising apparatus for transmitting the compass needle movement on modern warships. The sending compass is an ordinary instrument with an additional bolometric device below the dial illuminated by an incandescent lamp. The receiving compass is also an ordinary instrument similarly fitted.



EDISONIA EXHIBIT, SHOWING HISTORIC EDISON APPARATUS (*see* p. 128).

Among other German firms we noticed Hartmann and Braun, who also had a fine show of their famous instruments. Among these were a number of delicate devices for various elaborate testing purposes. W. C. Heraeus, of Hanau, exhibited an electric oven.

The Land und Seekabelwerke showed many samples of telegraph and telephone cables, among which we noticed a telephone cable for 1,000 double lines. The insulation of this comprises paper of different colours. A special protecting device for light and power cables was also shown.

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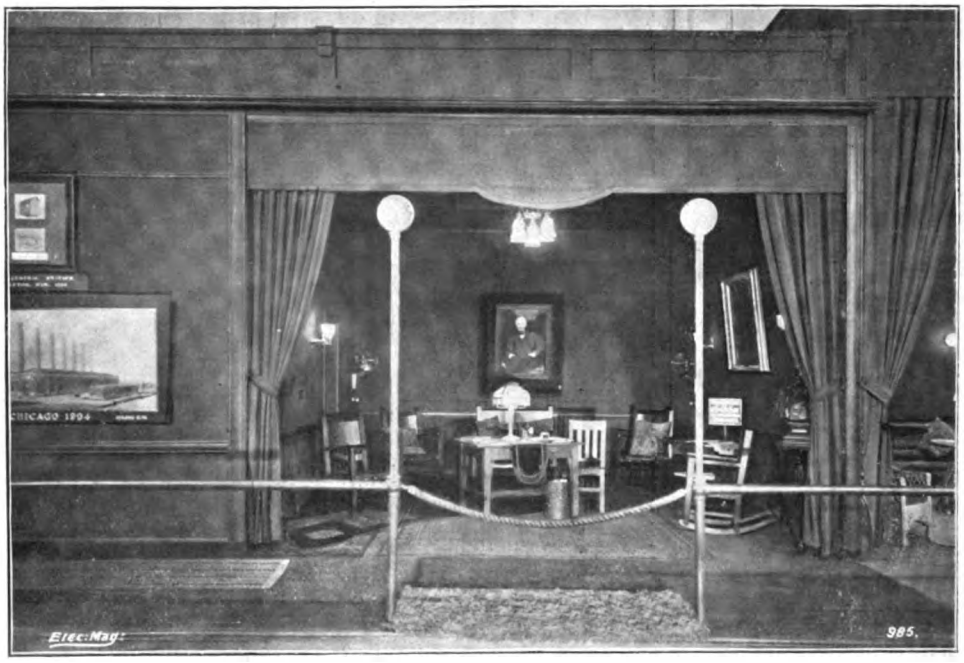
France.

The French electrical industry was represented at the St. Louis Exhibition by two important firms: The Société de l'Eclairage Electrique and the Société Alsacienne de Constructions Métalliques, the former contributing a 1,000-kw. high-speed quadruple expansion generating set, the mechanical part of which was executed by the well known Société Delaunay-Belleville. The engine has six cylinders, arranged tandem fashion, in three parallel and vertical rows of two, of which one is for high pressure, two are second expansion, another is third, and the remaining two are fourth expansion cylinders.

The three-phase alternator had a capacity of 1,500 kw. at 2,400 volts. This delivered current to arc lamps connected in series of 50 lamps at 3,500 volts inside the building and 100 lamps at 7,000 volts outside. The number of armature coils is very small, and this fact justifies the adoption of closed slots, rendering the lamination of the field pole unnecessary. The exciter was coupled direct to the alternator, and the engine was peculiar in that the steam motor, air and circulating centrifugal pumps, alternator and exciter were all coupled together direct and revolved at the same speed. The weight of the engine was about 40 tons.

Argentine Republic.

In addition to sending a delegate to the Congress the Argentine Republic was also represented among the exhibits. The stand was a small one it is true, containing telegraph instruments, carbon and lightning arresters, but from the maps displayed it was evident that important electrical developments were transpiring in the Republic.



HEAD QUARTERS OF "EDISONIA" PALACE OF ELECTRICITY (*see* p. 128).

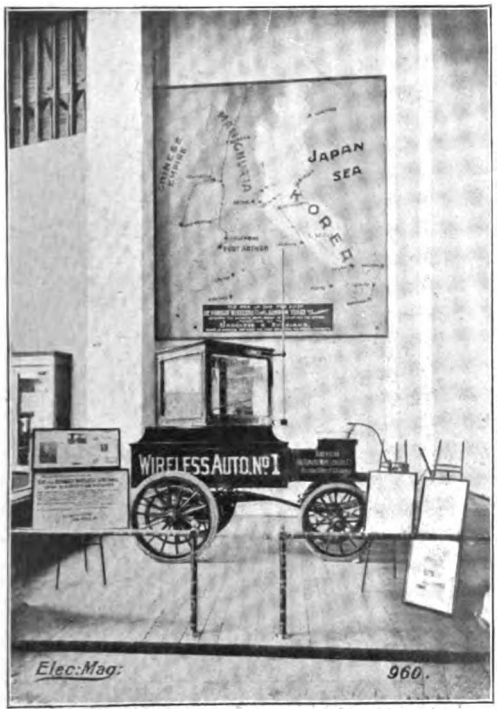
Belgium.

Although there are several prominent electrical firms in Belgium this country was content to send apparatus of an accessory character. There were some very artistic electrollers on view and also a number of storage batteries, telephone and telegraph apparatus. The exhibit was adorned with many photographs of electrical works established in the country.

Brazil.

Although Brazil possesses enormous future electrical potentialities it is at

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WIRELESS AUTO-TRUCK.
(A familiar sight on Wall Street, New York)

present utilising electricity for little more than telegraphic and telephonic purposes. On this account its exhibit did not extend into any wider field The telegraph and fire-alarms used by the Belgian Government were shown as well as a number of insulators and telephone apparatus.

Canada.

In the use of hydro-electric power Canada is a budding country, and electrical engineers in the mother country look to her for many striking developments in the future. Canadian electrical engineers did nothing more than show a model of the fine power house which the Ontario Power Co. is now erecting at the Niagara Falls. We refer more specifically to this in our descriptions of power houses and objects of interest visited *en route*.

Denmark.

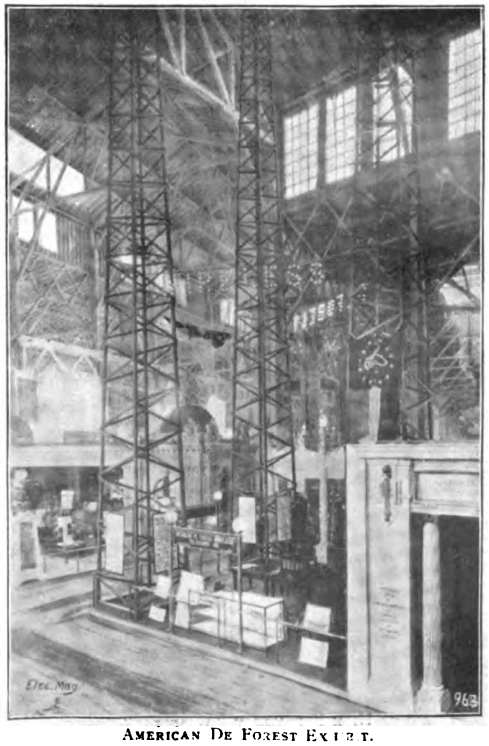
Denmark is not often heard of in electrical matters, but still thought fit to be represented in the Electricity Building. This exhibit consisted of primary batteries, and an extensive display was made by Hallesens, Enke. and Ludwigsen of Copenhagen.

Italy.

The Italian industry was appropriately represented by a historical collection of electrical apparatus made by Volta, Pacinotti, Belli, and Ferraris. Messrs. Olivetti and Co. of Milan, exhibited some interesting recording and integrating instruments. Pirelli and Co. of Milan, the celebrated cable makers, had a fine exhibit of cables and wires.

Japan.

Despite the unfortunate circumstance of being at war with Russia, Japan made it evident by her electrical exhibit that she does not intend to be left in the rear of industrial progress. A 150,000-volt testing transformer was undoubtedly the attraction of the exhibit. This had been designed by Mr. Iijima and built at the Shibaura Engineering Works, Tokio. The same Company also showed a small direct-current generator. The Oki Co. of Tokio had the largest exhibit, which included a Morse ink writer and double-current key and telephone apparatus. The Company, however, makes cables for telephone work. Japan has



AMERICAN DE FOREST EXHIBIT.

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evidently become sufficiently "electrified" to possess an Electrical Association. This body exhibited a table indicating the status of electrical industry in Japan. Saiga Tokichi exhibited photographs of an hydro-electric power station at Iyo.

Mexico and Portugal.

Both these countries were represented by plans and photographs of stations either projected or in operation.

Wireless at the Exhibition.

It was impossible to miss the presence of wireless telegraphs in going the round of the Exposition. Inside the Electricity Building the crack of the high-frequency spark smote sharply on the ear, and in the grounds the observation tower could not fail to attract the eye. The American de Forest Co. held the entire field and made a splendid show. Ten sets of de Forest apparatus in seven separate stations were in constant operation, transmitting messages about the grounds and for long distances outside. In the Electricity Building three wooden lattice towers each 75 ft. high had been erected, and from these depended the screen-like antennæ terminating in the transmitter below. The independence of the various stations was daily exhibited, simultaneous messages being sent without disturbances of adjoining stations. This was accomplished by tuning various instruments to the different wave lengths.

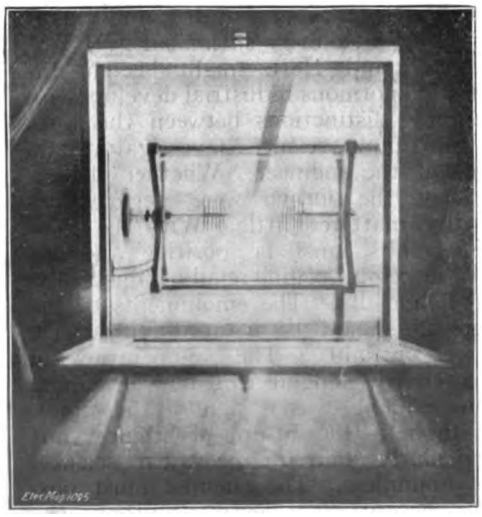
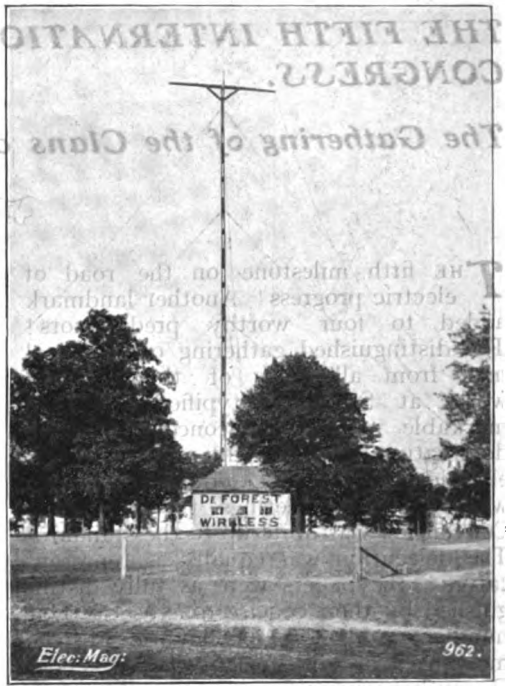


PHOTO OF HIGH FREQUENCY "WIRELESS" SPARK.



LONG DISTANCE WIRELESS STATION ON ART HILL.

The Observation Tower rose above all the other Exposition buildings, its extreme height being 300 ft. The space-telegraph station was on the 100-ft. platform which overlooked the beautiful expanse of Forest Park. The walls of this station were of glass. Messages were constantly despatched to two daily papers in St. Louis at the rate of from 3,000 to 5,000 words per day. The antenna wires on the tower led to a gaff extending from the roof, a distance of 200 feet. Five hundred volt direct current received at the Tower was transmitted by a motor generator of 240 volts, and on the platform a motor operated from this circuit operated a 2 kw. 60 cycle 110 volt generator. The ordinary Morse key was used for the transmitter. Messages were successfully sent to Springfield, Illinois, 105 miles distant.

The Company is now sending aerograms direct from Kansas City, Mo., to Cleveland, Ohio—without relay—825 miles all overland, and has opened for commercial business between Kansas City, St. Louis, Chicago, Springfield, Ill., Cleveland, Ohio, and Buffalo, N.Y. (This beats all records.)

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THE FIFTH INTERNATIONAL ELECTRICAL CONGRESS.

The Gathering of the Clans at St. Louis.

THE fifth milestone on the road of electric progress! Another landmark added to four worthy predecessors! The distinguished gathering of electrical men from all parts of the civilised world at St. Louis typified in a remarkable manner the concordant spirit dominating the thought and work of electrical engineers to-day. Compared with previous meetings the St. Louis Convention was quite up to the standard. The delegation was equally as representative; the papers were as fully distinguished by their concise tone as by their number, and the attendance at the meetings was in every way as good. From the point of organisation there was room for nothing but praise. The proceedings opened on September 12 in the music-hall of the Coliseum, St. Louis. Unfortunately the acoustic properties of the hall occasioned some difficulty in hearing a few of the speakers.

Prof. Elihu Thomson called the assemblage to order and introduced President D. R. Francis of the Louisiana Purchase Exposition who made the welcoming speech. In his remarks he referred to the objects and scope of the Exposition, and told his hearers how, after some argument on the part of organisers of the Exhibits, a separate building was allotted to electricity. His audience was naturally surprised that any doubts should have existed as to the claims of electrical engineering to separate recognition. Extending a hearty invitation to the members to visit the Exposition he concluded by thanking them for making St. Louis their meeting place.

Prof. Elihu Thomson then opened the Congress, briefly referring to the historic incidents responsible for its assembly there. Concluding with a warm tribute to the work of the Secretary, Dr. A. E. Kennelly, and the good judgment of the Treasurer, Mr. W. E. Weaver, he expressed the deep sense of American electrical engineers of the aid and encouragement springing from the co-operation of the technical institutions represented. Mr. R. K. Gray, then President of the Institution of Electrical Engineers, tendered thanks on behalf of that body, and Prof. M. Ascoli also replied for the Italian Association.

A hearty welcome was then given to the members by Prof. W. E. Goldsborough, who in a bright speech spoke of the labours of the Exposition authorities in assembling the electrical exhibits. The collection he described as "a demonstration of what has been accomplished in the field of electrical engineering, which is a physical embodiment of the effort of the Congress." Of the harmonious spirit of electrical workers there could be no doubt, a fact which he considered was substantiated by the large number of their representatives present.

The officers of the Congress being duly elected, President Elihu Thomson delivered his opening address. He pointed out how results of inquiry undertaken for its own sake by such men as Davy, Faraday, and Hertz might become the bases of enormous industrial development. He drew distinctions between the work of the pure science investigator and that of the engineer. Whether the results of the former were negative or positive mattered little. With the engineer results must be positive and his work successful, commercially, industrially, and financially. The emoluments of the engineer should be in accordance with his responsibility. The co-operation of research with engineering now becoming more evident, was a sign of the times. He thought the future of science, but particularly that of electrical science, was boundless. The chemist must possibly accept an electrical atom, the physicist an electrical inertia. Since the

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ether was only known to possess electro-magnetic properties, whatever that may mean, matter and all immersed therein might be electrical.

THE CONGRESS PAPERS.

THE Congress was divided into eight sections. Section A dealt with General Theory; Section B with General Applications; Section C with Electro-Chemistry; Section D with Electric Power Transmission; Section E with Electric Light and Distribution; Section F with Electric Transportation; Section G with Electric Communication, and Section H with Electro-therapeutics.

Section A.

This important section was presided over by Dr. E. L. Nichols, Cornell University, with Dr. H. J. Barnes, McGill University, as Secretary. Meetings were held on September 12, 13, 15 and 16. Most of the papers were of a mathematical character, and only a few of the total contributed were read, and a number of these in abstract. Dr. H. J. Barnes in a paper on "The Mechanical Equivalent of Heat Measured by Electrical Means" presented some interesting results obtained by himself by the use of this method. A paper on "Spectra Gases at High Temperatures," by Prof. John Trowbridge, gave particulars of various phenomena observed in the discharge of a high e.m.f. condenser through Geissler tubes. Dr. A. E. Kennelly's paper on "The Alternating-Current Theory of Transmission Speed over Submarine Telegraph Cables" was closely followed. In a mathematical examination of the problem he concluded that the receiver inductance should equal the sending circuit condensance, and that these values should equal the ohmic resistance of the circuit. The results were dependent on the signals consisting of a succession of regular dots.

By far the greatest interest in the sessions of Section A centred in papers "on the electrical system of units," by Profs. M. Ascoli, H. S. Carhart and G. W. Patterson, and Dr. F. A. Wolff. The first named thought that a system with other units than the centimeter, gramme, and second might be an improvement. The second two scientists mentioned, described many years work with the electro-dynamometer in determining the absolute value of the electro-motive force of the Clark and Weston cells. Many difficulties had been encountered, but results showed that the value of the electro-motive force should be 1.433 volts at 15 degrees C. Further investigation was, however, suggested before making a final statement. The last scientist referred to discussed the present legal status of the ohm, volt, and ampere. He referred to the differences in the units as at present legalised by the principal European and American nations, and recommended that steps be taken to bring about closer unification. In the discussion Profs. E. C. Webster, H. S. Carhart and J. Perry, Drs. A. E. Kennelly, R. T. Glazebrook, and F. A. Wolff, and Messrs. H. E. Harrison and C. H. Sharp all gave their views. The debate turned on fixing upon a concrete standard of e.m.f. such as the Clark and Weston cells or of supplanting both by the silver voltameter standard; and also on the rationalising of units in general. The American speakers favoured the retention of the standard cell but the foreign delegates were inclined to the silver voltameter. Regarding the general system of units all parties seemed to think it too late to make any radical change. It was also agreed that the time was not ripe for recommending legal changes in the recognised value of the e.m.f. and the Clark cell or of its replacement by the Weston cadmium cell.

Section B.

Section B covered the field of General Applications and contained papers upon widely varying subjects. Dr. C. P. Steinmetz was its Chairman and Prof. S. Sheldon was the Secretary. Mr. W. M. Mordey presented a paper on "Eddies and Hysteresis in Iron" which was read by the Secretary. From experimental studies it had been found that the eddy-current losses, even in very thin sheet steel were quite large compared with the total loss and should not be neglected. He suggested that tests for iron loss should be conducted with a wattmeter on sheets of commercial size. This paper, together with that on "Magnetic Viscosity," by Mr. M. R. Jouaust, formed the subject of considerable discussion. Dr. C. H. Sharp's paper on "The Commercial Equipment of a Testing Laboratory" contained very valuable hints on the essential equipment of such a laboratory, but his suggestions were not discussed. Mr. A. Nodon's paper on "Electrolytic Rectifiers" was abstracted by Dr. C. P. Steinmetz; its chief details dealing with the difficulties of magnetic induction rectifying devices and describing the author's now well-known valve. The testing of alternating-current generators by Mr. B. A. Behrend was a paper which provoked much discussion. Mr. Behrend, criticising the sectionised armature test suggested by Mordey, splits the field into two sections, connecting these so that the e.m.f.'s induced in the armature are in

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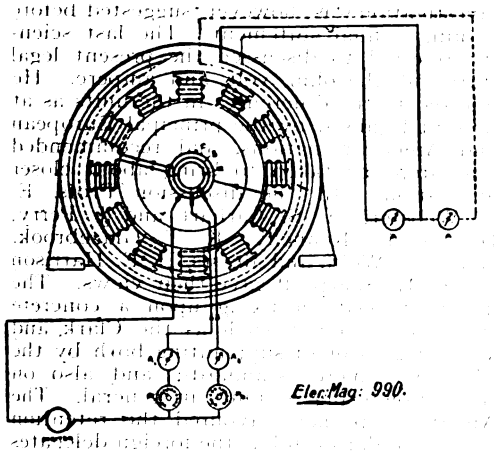


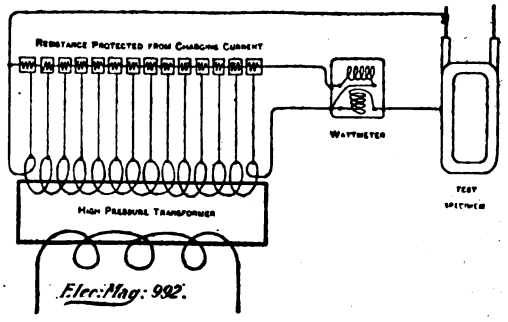
DIAGRAM OF CONNECTIONS OF MR. BEHREND'S ALTERNATOR TEST.

opposition. Prof. H. J. Ryan seemed so pleased with the suggestion that he proposed a systematic comparison of results obtained by actually loading various machines and by calculations based on Mr. Behrend's method. Dr. Steinmetz said it was a good plan to run a machine on short circuit for a certain time and on open circuit with excess excitation for a certain time to get the full temperature rise. The papers in discussion on Tuesday were devoted to Electric Railway Traction, but especially to Single-phase Motors and were taken in conjunction with Section F. The latter formed the subject of papers by Dr. Steinmetz, Max Deri, Marius Latour, Dr. O. S. Bradstad and Ernst Danielson. These were all of a highly mathematical character and do not lend themselves readily to abstraction. Mr. Latour, who has studied the problem for many years, discussed the compensated repulsion motor which has been the subject of his research. He described a method giving improved commutation at all speeds and practically eliminating sparking troubles. Of the papers on railway problems those by Mr. P. M. Lincoln and Dr. F. Neithammer were taken up and discussed. The relative merits of single *v.* polyphase currents for railway work was the crux of the debate in which Messrs. E. K. Scott, B. G. Lamme, C. P. Steinmetz, A. H. Armstrong, and H. W. Leonard took part. Dr. C. P. Steinmetz and Mr. E. K. Scott took up the cudgels on behalf of single and polyphase currents respectively. The latter made a point of the constant torque of polyphase and direct-current motors compared to the pulsating torque of the single-phase series motor. He further compared them to three-crank and single-crank engines. With alternating-current motors a heavier locomotive was required than with direct-current motors to avoid slip, and he further thought polyphase had the advantage in that if one transformer failed the remaining two would carry the load.

Dr. Steinmetz on the other hand directed attention to the absence of dead centre with a series-motor, the torque of which pulsated at a rate dependent upon the frequency but independent of the speed. As to the single- and three-crank engine, single-cranked tandem compound engines were as good as two crank engines, the pulsation torque not being objectionable. It seemed best to generate polyphase and distribute single-phase but the ideal system was both to generate and distribute the latter.

On Thursday proceedings were opened by the abstraction of Prof. S. P. Thompson's paper on "Plunger Electro-magnets," by Dr. Steinmetz. This dealt with the design of such magnets to give a constant force throughout a large range of stroke. Prof. H. J. Ryan, one of America's authorities on power-transmission work, presented an able paper on "The Design of Insulation." It is replete with valuable data on methods of design for dielectrics, and emphasises the fact that mathematics can be used far less proportionately in determining necessary dimensions in the design of insulation than for the circuits accommodating electric current and magnetism. Mr. C. Day's paper on electric motors in machine shop service was then read, the author's main contention being that the motor-driven tool should not be a combination but a unit suited for certain specific ends. The purchaser of such a tool should be assured that the drive had received the same care in design and construction as other parts of the machine.

At this juncture Sections B and E combined to discuss Col. Crompton's paper on "The Standardisation of Dynamo Electric Machinery." The paper reviewed British efforts at standardisation, detailing the



THE TESTING OF INSULATION.
(From Prof. Ryan's Paper.)

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recommendations of the British Engineering Standards Committee.

In all matters except frequency these were in accord with the report of the Standardisation Committee of the American Institute of Electrical Engineers. The latter recognises 60 and 25 periods, whereas the British Committee recommends 50 periods and a secondary frequency of 25. Some very interesting opinions were exchanged in the discussion, which assumed a representative tone and turned chiefly upon the matter of frequency. The American standard of 60 cycles in vogue for some six years past, the wide differences in frequency prevailing in Great Britain, the adoption of 50 cycles in Germany and the absence of standardisation in Italy, all presented difficulties in the settlement on an International figure. Several speakers, notably Dr. Steinmetz and Mr. C. F. Scott, pointed to the danger of legalised rules for constructing apparatus. Standardisation might hamper development and any rules laid down should be suggestive of good practice, rather than indicative of how machinery should be built. Dr. R. T. Glazebrook endeavoured to correct the impression that in England the recommendations would be legalised, because no fixed rules were made and no supreme council existed to enforce their enactment. Col. Crompton in reply pointed to the valuable work done by the Board of Trade in the past, stating further there had been no compulsion nor had any obstruction to progress been evident. At the final meeting of the section papers relating chiefly to the design and regulation of alternators were presented. The authors of these were Messrs. A. Blondel, P. Boucherot, C. A. Adams and D. B. Rushmore. Mr. A. Heyland, who is an expert on the subject, presented a paper on "Recent Developments in Compound Alternators with Alternating Current Self-excitation." This described a system for compounding single-phase or polyphase machines by leading the alternate-current generated to the field windings for excitation and compounding by a special commutator. Mr. Heyland is renowned for the numerous designs of machines of this type which he has put forward in recent years. The engineers discussing the paper considered the proposals satisfactory enough for small machines but tending to undue complication when applied to larger units. Compounding when carried out in the generator itself was apt to be expensive, and more satisfactory methods were in use for performing this work externally. Mr. H. M. Hobart's paper on a method of designing induction motors called forth the most eulogistic remarks on the work of the author and the liberal and concise manner in which he always furnished his information.

Section C.

Section C held its meetings in conjunction with the American Electro-chemical Society, the Faraday Society of Great Britain, and the Bunsen Society of Germany. Prof. H. S. Carhart officiated as Chairman and Mr. Carl Hering as Secretary. Only one paper was presented on the first day, that by Prof. T. W. Richards on the relation of the hypothesis of compressible atoms of electro-chemistry. On the second Dr. W. D. Bancroft read his paper on the chemistry of electro-plating, which was an endeavour to classify the causes leading to bad deposits. Prof. C. F. Burgess in the absence of the authors read a paper on the carbon cell by Prof. F. Haber and Dr. L. Bruner. In this a new theory was proposed of the action of the Jacques cell, this being generally attributed to the presence of manganese. A lively discussion ensued in which the author's views were strongly opposed, especially by Mr. C. J. Reid. At Thursday's meeting Dr. K. E. Guthe, of the National Bureau of Standards, gave his paper on the silver voltameter. In this he contended that the silver voltameter was as good as a standard cell from points of accuracy and reproducibility, but for practical reasons the standard cell was more likely to meet with acceptance. Dr. R. T. Glazebrook outlined the work done in the British National laboratory ten years ago with Lord Raleigh. A paper on a study of the materials used in standard cells and their preparation was then presented by Profs. H. S. Carhart and G. A. Hulett. Dr. P. L. T. Heroult then gave his paper on the use of the electric furnace in the metallurgy of iron and steel, first reviewing his own work in this sphere. He pointed to the limitations of the electric furnace for the induction of iron ores, and was not sanguine of its superseding the blast furnace except where electrical energy was very cheap. A general discussion then followed on a paper, "The Present Status of the Edison Storage Battery," presented by Dr. A. E. Kennelly and S. E. Whitney. This was an historical account of the development of the nickel-iron alkali cells from 1898 to the present time, together with the results of numerous tests made. It was pointed out that the cell approached the steel structure in dynamo construction in respect to the number of watts per pound. The efficiency was low, but it was full proof and would stand the worst treatment.

Mr. J. S. Edström's paper, "The Electrical Abstraction of Nitrogen from the Air," was of considerable importance.

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seeing that the present increasing rate at which sodium nitrate was used would exhaust all the known deposits about 1940. The paper showed what had been and is now being done, and in the latter respect presented a very promising field for the use of electrical energy. The process of Birkeland and Eyde was described, the apparatus in which the nitrogen unites with the oxygen comprising an oven with two metal electrodes between which a high-pressure arc plays, the arc being moved rapidly by means of an electro-magnetic field.

Section D.

It was not surprising to find Mr. C. F. Scott and Dr. Louis Bell as Chairman and Secretary respectively of this section. From the practical point of view its sessions were the most interesting of any, while its discussions would be difficult to beat for their liveliness. Most of the authors of the papers hailed from the Pacific coast, the cradle of high-voltage power transmission, cradle, of course, no longer but a very flourishing centre of activity. After papers by Messrs. Bignami, Scott, Peck, and Smith, Mr. F. G. Baum's paper on high-potential long-distance transmission and control was read. Mr. Baum has committed much to paper on this subject, and his compilation was a notable addition to many worthy predecessors. Among references of interest was one to the greatest transmission system in existence, that of the California Gas and Electric Corporation, which operates 700 miles of 50,000-volt transmission circuits. On these lines spans of from 1,000 to 1,800 ft. were common between hills and steel towers with iron pins were now used for extension work. Mr. Baum remarked on the freedom from lightning troubles with higher voltages, stating that he had practically abandoned lightning arrestors, using only the horn type with wide gaps, but even these were needless with 60,000 volts. A paper on American practice in high-tension line construction and operation was read by Dr. F. A. C. Perrine, this being a review of American practice. Papers by Messrs. Buck and Blackwell were then read and discussed, as was also Mr. M. H. Gerry's paper on high-tension transmission lines. Messrs. Kelly and Bunker contributed a valuable paper on some difficulties in high-tension transmission and methods of mitigating them. The discussion also turned on papers read the previous day. Mr. Gerry's ideas on wooden pins were challenged by several speakers, but Mr. P. N. Nunn championed his cause and also that of the all wood line construction. Mr. Nunn also read a history of the work of the Telluride Power Co., surveying work done by it during fourteen years' strenuous experiment. This paper makes most interesting reading. From the tone of the papers and the subsequent discussion a marked tendency was everywhere evident to raise the transmission voltage. With 60,000 volts as the present limit further increases must depend on the evolution of better insulators. These are the real limiting factors and not the generating controlling apparatus as these can be constructed for pressures up to 100,000 volts.

Section E.

In Section E the central-station men had their fling. Presided over by Mr. J. W. Lieb, Jnr. and Mr. G. S. Dunn, as Chairman and Secretary, the interest in the sessions was thoroughly well maintained. Operations were appropriately commenced by papers on meters and rates for electricity supply by Messrs. Wright and Fodor respectively. The paper of the latter excited the greatest comment. The author proposed a unit rate for light and power, this to be divided into two classes according to the time at which energy is taken. Mr. Fodor's conclusions did not meet with general approval, the English engineers who were present in force signifying their views with emphasis; in fact, they were practically unanimous as to the impracticability of a single scale of rates for both lighting and power. Mr. G. N. Eastman, of the National Electric Light Association, next read a paper on the Protection and Control of large high-tension alternating-current distributing systems. To obviate excessive electrostatic disturbances on the system a permanent grounding of the neutral was essential. Mr. W. C. L. Eglin read a paper on "Rotary Convertors and Motor Generator Sets," which was briefly discussed. Mr. C. Rodenburg's contribution on "The Prussian System of Electric Tram Lighting" was then read, the author describing a most interesting system for obtaining constant illumination despite e.m.f. variations. The regulation of the voltage for differences in the generator speed without special devices was also detailed. Among the devices used is a small iron wire in the circuit of each incandescent lamp, and by this constant e.m.f. was obtained, increases of current raising the temperature of the wire and increasing its resistance. Where the dynamos were driven from the car axle an electrolytic rectifying cell was introduced to interrupt the circuit as being preferable to automatic low-current, circuit breakers. A brief discussion was participated in by Col. Crompton and Prof. G. F. Sever. Signor E. Jona then presented an extensive paper on "Insulating Materials in High-Tension Cables,"

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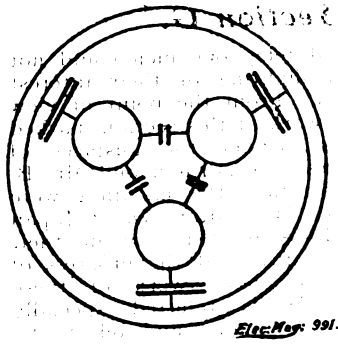


DIAGRAM ILLUSTRATING CABLE CAPACITY. (From Mr. G. N. Eastman's paper.)

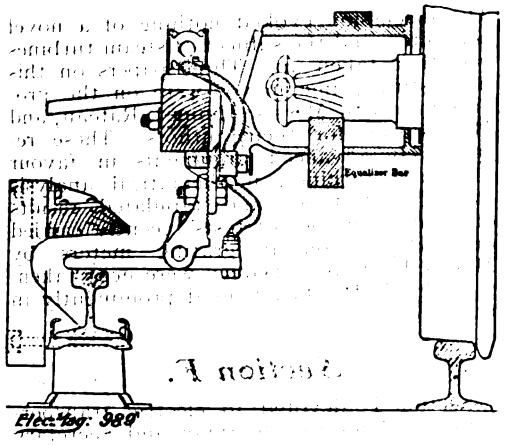
this being a highly mathematical treatment of the subject, but one of great importance and permanent value. On the subject of central-station distribution systems Messrs. Torchio, Dow, and Stearn presented important communications. The latter was a bold attempt to prove that direct-current apparatus was unsuited for central-station work in large cities, but in the discussion that followed, this statement was not taken seriously. Other papers presented by Messrs. Ferguson, Feldmann, and Herzog were read and discussed, the English engineers figuring prominently in debate. The papers in question dealt chiefly with underground construction and the distribution of voltage and current in closed conducting networks. Dr. C. P. Steinmetz made some interesting disclosures regarding the electric arc, and described some of his recent investigations of the mercury arc stream and the magnetite or flaming arc. He pointed out that the typical arc in air is that between iron and copper or their conducting oxides, while the typical vacuum arc was the mercury arc stream. Both these act as rectifiers under ordinary conditions. Prof. A. Blondell's paper on "Impregnated Arc Lamp Carbons" was read by Dr. Louis Bell and reviewed the development of the Nernst lamp and the mercury arc. Mr. Lieb, in discussing the paper, referred to trials of the Blondell lamp in which a 200-watts lamp gave better diffusion than a 500-watt enclosed arc of the usual type with carbon electrode. Prof. Lombardi's work on "Stroboscopic Observations of the Arc" was then given, his paper being illustrated by many photographs. Dr. Steinmetz confirmed the investigations from his own recent experiments. An important paper by Mr. G. Goettling on "Storage Batteries as an Adjunct to Central Station Equipment" contained valuable data on this subject, details of the construction of the plates being fully entered into. A paper on "Nernst Lamps" by Mr. H. M. Potter then followed, and in this details of the present American practice in constructing Nernst lamps were given. The discussion evoked nothing of a novel character, and the subject of steam turbines was then taken up. Three papers on this interesting prime mover were on the programme, with Messrs. Emmet, Rateau, and Hodgkinson for their authors. These respectively advanced arguments in favour of steam turbines, mathematical analysis of different types and tabulated results of a large number of tests recently carried out. Papers on integrating meters by Messrs. Haskins and Green were next taken, and Mr. J. R. Dick figured prominently in the discussion.

Section F.

Section F, devoted to electric transportation, had for its Chairman and Secretary Dr. Louis Duncan and Mr. A. H. Armstrong. The subjects for discussion in this section were of undoubted international interest, as was evident from the attendance at the meetings. Proceedings were opened by Mr. Philip Dawson, whose paper, "Electric Traction on British Railways," urged the necessity for the electrification of suburban and short-distance interurban systems in this country. Messrs. Ward Leonard and Sprague discussed the paper, the latter pointing to the chief success so far of the electric railway where stoppages were frequent. The main factor in electrifying steam lines was density of traffic. For intermittent service over long lines electrical men might as well be frank in admitting that they could not use high-power units as economically as steam. Mr. Leonard was of opinion that in comparing steam roads too much stress was laid on cost of wages or cost of fuel. An important paper was that of Mr. J. B. Entz on "Storage Batteries." In this the application of batteries to railway service was considered and the economies obtained by their use pointed out. The total estimated gain was put at from 15 to 20 per cent. Referring to the construction of the cells he thought the positive plates should be of Planté type and the negative plates should be pasted grids. Mr. Sprague in discussion emphasised the importance of storage batteries, referring to their adoption on the new electrified section of the New York Central. The ambitious scale upon which American electric railway systems were planned prohibited the use of storage batteries in central stations, but they could be advantageously installed in sub-stations. Mr. J. S. Edström referring to European practice said that batteries were used with great advantage on small lines, especially those running few cars.

Joint meetings were held with Section B on Tuesday, and the papers on Railway

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SECTION THROUGH PROTECTED THIRD RAIL.

(From Mr. L. B. Stillwell's Paper "The Wilkesbarre and Hazelton Railway. The only protected third rail line in the States.")

Motors will be found in the notice of that section. On Friday Mr. F. P. Behr presented a paper on the Mono rail, this being read in the Westinghouse auditorium in the Electricity Building. Mr. F. J. Sprague's paper, "The History of the Electric Railway," was a very full account of that development and was followed with great interest. Dr. Louis Duncan abstracted his contribution on "The Application of Electricity to Railroads," in the course of which he considered that electrical men could promise little with respect to decreased expenses and increased operating facilities to trunk railroads. For general railway work electricity had no advantage over steam. Any system using more than one overhead conductor was impracticable, and experiments clearly pointed to the operation of trunk lines by polyphase currents as unfeasible. The single-phase motor possessed objectionable qualities, and the direct-current motor was its superior with respect to weight, simplicity, reliability, and general perfection. This last statement brought up Mr. B. G. Lamme, who urged that with the alternate-current motor the use of more current voltage in the windings, thereby obviating certain troubles inherent in the direct-current motor, there would be no special difficulties in applying the alternate-current motor to railway work, nor did he anticipate trouble with the higher trolley voltage. Mr. E. Kilburn Scott boldly championed the cause of the polyphase traction motor, proudly pointing to the work done in Italy in this sphere. Other speakers followed, giving diverse opinions as to the use of single and polyphase motors.

Section G.

Telegraph and telephone men could not complain of a slighting of their interest at the Congress. From the point of view of progress the work of this section marked rapid advances. Under the auspices of Mr. F. W. Jones as Chairman and Mr. B. Gherardi as Secretary, the meetings were most successful. Mr. Saitaro Oi of Japan and Mr. J. Hollis of Hungary in their respective papers reviewed the progress of telegraph and telephone work of these countries. Mr. Hollis referred specially to simultaneous telephony and telegraphy over complete metallic circuits, the system described being very similar to that of Van Rysselburghe. Mr. Hesketh said that in Australia the same thing was done with a grounded circuit. A system was also in use there operating two telephone circuits with three metallic conductors. According to Major Reber this simultaneous operation of telegraph and telephone circuits was quite successful in the army with a grounded circuit. A paper on "A New Danger to Lead Covered Aerial Cables" by Mr. J. Hesketh referred to cables being attacked whether bare or taped. From the remarks of Mr. Wotton it was gathered that much trouble had been experienced in the South with an insect which bored its way through the lead sheaths. Major S. Reber's paper on the telegraph, telephone, and cable in war was then taken and discussed. Replying to an inquiry the author stated that wireless telegraphy had not proved successful for long-distance military purposes. He said that the telephone receiver was better for field purposes than the coherer. Messrs. Delany and Potts' papers were then taken up and discussed.

"Telephony."

An important paper on "Telephone Problems in Large Cities" was then presented by Mr. F. J. Dommerque, in which a combination of the manual and automatic systems was suggested as a partial solution. This paper was very fully discussed during two sessions. Mr. K. B. Miller's paper "Automatic *v.* Manual Telephone Exchanges" was read by title and gave rise to quite an extensive debate. The automatic came in for some severe criticism, but Mr. Miller, supported by Messrs. Delany and McNaier, managed to hold his own very well.

Discussing Mr. H. B. Hayes' paper, "Loaded Telephone Lines in Practice," Dr. Kennelly referred to its practical and theoretical value in glowing terms.

The last paper of the session was read by Mr. J. C. Kelsey and entitled "Two-Strand Common Battery System." By this arrangement it was possible to build boards having

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18,000 lines connected. The system had given excellent service wherever installed.

Wireless Telegraphy.

A whole day was devoted to the subject of wireless telegraphy, the papers presented being mostly historical accounts of certain well-known systems and apparatus. Marquis Solari dealt with the wireless telegraphy of the Italian Government, describing in detail the development and technical aspect of the Marconi system. Mr. J. Stone described very fully his own system of selective wireless telegraphy, the subject being treated from a mathematical standpoint. Dr. L. de Forest read his paper on electrolytic receivers in wireless telegraphy, this describing the various wave detectors used. His description of the detector bearing his name excited great interest. He also gave details of results obtained with this detector in long-distance and overland wireless telegraphy. Prof. J. Fleming's paper "The Present Status of Wireless Telegraphy," which was read by title in the absence of the author, was a very complete record of the Marconi system.

At a joint meeting held with Section F a paper by Prof. G. Sever entitled "Electrolysis of Underground Conductors" gave rise to a very lively discussion. Prof. Sever said that in New York the lead sheaths of some underground cables were bonded to the elevated structure by copper wire and that currents supply as 1,500 amperes passed through this wire. In spite of elaborate precautions, telephone cables conveyed very large currents even to thousands of amperes. Mr. Gherardi pointed out that in spite of this they were able to cope with the matter by co-operating with the street railway people. Mr. J. S. Edström said there had been very little trouble in Europe with electrolysis. In Berlin and most German cities, also in Switzerland and Sweden, there was very little difference of potential between any two points on the rails. Mr. F. W. Jones outlined the experiences of the Postal Telegraph Co. since 1880. Where underground telegraph cables lay parallel to electric railways certain sections had been eaten out, but by making a good return wire from points where currents were observed to leave the cable sheaths back to the railway generator all trouble had been obviated. In fact, he said the Telegraph Co. loaned its cable sheaths to the railway companies to take the return current to the generating stations, the sheaths being bonded to their return wire.

Section H.

The bond of union between electricians and medical men is becoming constantly strengthened. The inclusion in the Congress of a section of Electro-therapeutics is sufficient evidence of this, while the attendance at the meetings of this section and the interest taken in the papers presented, clearly indicate that medical men realise the valuable assistance they are afforded by electrical science. A number of instructive papers were read, these dealing chiefly with improvements in apparatus and the application of medical electricity in both the diagnosis and cure of various diseases. X rays and high-frequency currents naturally figured largely in the proceedings. The section was presided over by Dr. W. J. Morton as its Chairman, and Mr. W. J. Jenks as Secretary.

At the time of taking this issue off the press, we hear with profound regret of the sudden death of Mr. E. H. Mullin, of the General Electric Company, who accompanied us throughout the Tour.



MACHINERY HALL, ST. LOUIS EXPOSITION.

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The
Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. III. NO. 2. (14th Issue.) LONDON. FEBRUARY 28, 1905.

RETROSPECT AND PROSPECT.

A GENERAL survey of electrical engineering throughout the world during 1904 reveals a continued and steady progress in all branches. The science and practice of electricity has come to be regarded as an integral part of civilisation, and is no longer looked upon as some escaped laboratory freak. We often hear that electricity is the power of the future, but from the broad outlook we obtain of things electrical, evidences point to its being very much the power of to-day. From all quarters come signs that the old-time prejudices are being broken down, and electrical developments now meet with proper and becoming recognition, even where formerly rival powers or illuminants held undisputed sway. This in itself is encouraging, and it should be more so in Great Britain than anywhere else, for though the electrical industry was born in these tight little islands its appearance created no enthusiasm, and it was forced to seek room for expansion outside. Now like a true home-bird electricity is returning to her own, and with characteristic vigour is roundly trouncing her former persecutors. Both gas and steam are now being gradually displaced by glow-lamp and motor, in spite of highly coloured reports to the contrary. As regards the former, the keener spirit in which the gas interest has taken up the cudgels points to uneasiness at the increased consumption of electricity for lighting purposes. The inverted burner, which is but a poor plagiarism of the pendant glow-lamp, has been put forward as a special inducement to consumers to abandon the latter, and the Gas Exhibition was only a species of pitchfork to hustle matters. These attempts at burning gas upside down seem to work out rather hard on fittings and ceilings, and to our mind they teach more about the impurities of the combustion products of a gas-jet than any of their predecessors. One is apt to wonder what the London Coliseum would look like if lighted with inverted gas-burners!

In every respect it seems to us that electricity has had by far the best of the struggle during the past year, and especially in street lighting. What gas has gained with high pressure lighting has been secured by a greater complexity of apparatus, but with electricity the opposite is everywhere noticeable. Arc lighting is now becoming distinguished by improved magazine lamps, enclosed lamps with greatly increased life and general simplicity of apparatus. This process of reduction of accessories will continue to mark further developments in arc lighting. In America and our Colonies gas seems only to find a second place, and although charges for current are much higher than those paid here, the difference can readily be explained. Prices always fall with the greater use of any commodity, and this will be evident before long in the directions mentioned. After all, electricity has no occasion for uneasiness, as the efforts of her exponents constitute steady and encouraging research in a broad field of unlimited possibilities, in contradistinction to the

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struggles of the gas interest in exploiting methods and devices possessed of inherent and incurable failings.

In supplanting steam for purposes of industry and transport, electric power has done much during the past year. Industrial establishments are the more difficult of capture as each possesses its own little power centre, generally presided over by a steam engineer of many years' standing. This is specially noticeable in textile factories where for years the steam-engine has reigned supreme, and around it have crystallised ideas and notions hard to break through. The shipbuilding and iron and steel industries show a marked partiality for electric power, and the great installations so generously put down in the United States and on the Continent have been copied on smaller scales at Newcastle, Barrow, and Sheffield with equally encouraging results. Minor trades requiring power are being gradually transferred from the gas to the electricity supply mains, and central-station records contain reports of repeated scores over the gas-engine by large electro-motors. The power companies in this country are getting into their stride, and several should have something to show for their labours at the end of the present year.

Long-distance power-transmission work has been vigorously pushed forward during the past year with the most promising results. Canada and the Western United States have furnished records of the extreme virility, the former in the amount of power transmitted from a given spot, and the latter in the extra high voltages used. The proceedings of the American Institute of Electrical Engineers last year reflected clearly the enterprising manner in which hydro-electric power plants were studied and discussed. It is to be hoped that those members of the Institution who visited the States in the autumn will do something to stir up the parent body at home and raise the practical aspect of its proceedings to a much higher level than has hitherto been evident. The International Electrical Congress at St. Louis afforded excellent opportunities to representatives of the world's electrical men to exchange ideas on power-transmission matters, and doubtless much of value will have been imparted and received all round. The tendency has been towards the perfection or improvement of apparatus rather than to wildly raising voltages of transmission. A pause has been made, as it were, to bring up the rear and consolidate the entire advancing party, a proceeding which will admit of more uniform and efficient progress being made. A noticeable feature of transmission work is the desire to abandon the lightning arrester with the increased voltages, as both inadequate and unnecessary. This spirit has spread doubt and dissension among the ranks of engineers in charge of lower voltaged plants as to the utility of the lightning arrester at all. There are also not wanting indications of a return to single-phase methods as the outcome of improvements in the traction motor of that ilk. Certainly something will have to be done to bring about uniformity throughout a system where trains and trams, and lighting and power are supplied from one station, and one-phase methods present the only hope of securing that uniformity.

Steam traction has suffered severely at the hands of electricity during the past year, and the former placid attitude of its advocates and exponents has undergone a marked change. Abroad, and more particularly in America, the shortcomings of the steam locomotive have not only been exposed, but that much respected veteran has been simply "pushed off the road." For suburban traffic it has met with nothing but condemnation, and electric locomotives have promptly been developed to take its place. The work on the New York Central is nothing short of a triumph for electricity, and an achievement which marks an era in electric traction; further, the locomotives typify what can be done with direct-current motors when the most efficient system is desired of applying electric tractive effort to the wheels of a locomotive. There is certainly nothing to show that one-phase motors, even of the commutator type, could be similarly applied to give such highly satisfactory results. Speaking of this motor brings us to the interest taken in it during the past year. Both Americans and Germans have vied with each other to get their respective motors into heavy work first. Finzi's Milan trials were but the prelude to unexampled

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activity in both camps, and it is doubtful with which party the advantage lies. A suspicion has got into the air that developments in this direction are merely attempts to corner trade by the great electrical trusts, and accordingly lack sincerity. Whether this is actually so cannot be said with truth by any one, but there was a significant coincidence in the appearance of the various Continental and American types of motors. This, of course, may be explained by the fact that with a world market as contrasted with a merely home one, international competition is set up, and the same commercial diplomacy would be called into play, but on a much wider scale. One thing, at least, is evident, that none of the purely English electrical concerns have developed a single-phase commutator motor and most of them appear quite indifferent to such a machine. Doubtless when a demand arises they will tender to fill it, but with no precedent in design of their own, and no practical examples, they would seem placed out of the running with competitors previously more active and alive to the situation.

From the point of prime movers the year has been a disappointment, though from the aspect of gas rather than steam. The gas-engine was going to arise in large vertical units and assail even the inner stronghold of the turbine, but it has failed to appear except in almost microscopic guise. The turbine, on the contrary, has responded well to the energies expended upon it, and high hopes are held of its retaining the field for some time to come. It will at least rid us of the monster reciprocating sets which, though imposing enough in their way, have quite outstepped the ordinary limits of their usefulness.

We publish this month reviews of the chief events in the various branches of electrical industry represented by our sections, and greater details will be found there of the outline given above. All things considered, the general trade depression has not checked research or development, and this fact augurs well for the future. Speaking for this country, there is no reason why its trade in electrical machinery and apparatus should not be enjoyed by its particular circle of electrical manufacturers, whose reputation is, after all, beyond compare but whose methods need stiffening to enable competition from other countries to be fairly met. That competition has done English manufacturers a great deal of good, and the stimulus to be derived from it will, we are persuaded, help them to hold their own against all comers. Other countries have taken from us, and improved on, our ideas. With these they are now returning, but our opportunity lies, not in accepting such avowed improvements, but in still further developing from them. It is in this spirit that we regard the future. We cannot hope to rival countries greater, in a geographical sense, than we, where electrical schemes are proportionately greater, but we can maintain our own individuality, in so far as electrical affairs are concerned, and thus defeat those who would take even this away from us. We are not quite "Americanised" in electrical matters if we have a few third-rail lines in our midst. With every deference to our American cousins and continental *confreres* we can still "think electrically," and we look to the immediate future for opportunity to vindicate our claim to independence of thought and action in electrical affairs.

A Phenomenal Success.

Our First Anniversary and Souvenir Issue has been successful beyond our best anticipations. It describes in graphic form the American Tour of the Institution of Electrical Engineers, the International Electrical Congress and the St. Louis Electrical Exhibits.

You will want a copy for reference and we have just a few left.

Read what Mr. J. Lynn Marr, Director Sunderland Forge and Engineering Co., Ltd., says about the issue:

"The paper you have just published gives a splendid account of our American trip, and I am sure will always be retained as an exceptionally interesting souvenir by those who were fortunate enough to take part in this memorable tour. Your article is so accurate and well put together that those who were not able to go with us to America will practically be able to get the whole trip for the price of your Magazine, and to learn from it the progress the Americans have made in Electrical Engineering."

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The Anniversary and Souvenir Issue.

WE cannot better open our Editorial remarks this month than by a few words of thanks to our friends, the world over, for their hearty support during the past year, and also for the unanimous spirit in which they received our Anniversary and Souvenir issue. We look back on the last twelve months with pride and satisfaction in being accorded at the outset so splendid a reception, and in maintaining the position we then took up in the field of electrical journalism. As to the Souvenir issue it was in great demand immediately after publication, on both sides of the Atlantic, and our best energies were also needed to meet the calls from all parts of the world. By this time the story of the American Tour will have reached the four quarters of the globe, and been read, and we doubt not, kept for reference by every grade of electrical engineer. We naturally expected some hints at our being late in producing matter of interest a few months before, but such criticisms display a profound ignorance of the enormous labour entailed in the compilation of so monumental a work, and in subsequently getting it printed and published. The ratio of complaint to eulogy is, however, overwhelmingly in favour of the latter, and consequently we feel more than repaid for the care and thought we had of necessity to expend. The circle of our readers has, we are convinced, been immeasurably widened by the appearance of the Souvenir issue, while its greater expansion has tended to cement our good relations in inverse proportion to the distance.

In the succeeding note we outline in some detail a remodelling of the Sections of the magazine, a scheme which will we hope enlarge its scope and materially add to its interest. While on this topic we may incidentally refer to other important developments we now have in hand which, when brought to fruition, will not only make us better known but better liked "on all counts." Readers need have no qualms of there being a speedy Americanising of this journal following up our recent visit to the United States. Americans can give us points in technical journalism we will admit, but we still know a thing or two and can go one better, and this knowledge we are exploiting on behalf of our readers and supporters, to give both the full benefit of our experience. We are getting the right class of matter for the reader, and for the manufacturer we are ensuring a circulation among those whose purchasing power is all they could desire. In addition we are not neglecting either the younger members of the profession who will sooner or later be giving orders for electrical machinery, or that class which though reckoned among the "hewers of wood and drawers of water" yet possess a living interest in the electrical matters nearest to their daily affairs.

We stand within no circumscribed area, located somewhere in the electrical industry, and from that raise a puny voice on behalf of a particular speciality. Our aim as an international record of electric progress is to furnish valuable information, and impart to electrical men useful data culled from the best-known sources of technical information; and not only this, but we also have at disposal the services of the most eminent electrical engineers the world over, whose experience imposes the hall-mark of authority on the opinions they express in our columns, and is of undoubted utility in the field of practical application. It is with such a programme we open the new year, and we anticipate an ever-increasing apprecia-

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tion of our efforts on behalf of electrical engineers of all classes and in all lands.

About our Sections.

WITH the experience of two volumes behind us and a number of hints from readers before us, we have carefully considered a remodelling of the various Sections of the magazine, as well as the desirability from the literary standpoint, of dropping one or two of them. The result of our deliberations is presented in the arrangement of the Sections this month. One radical departure will be noticed. The Special Articles containing important matter relative to certain Sections will not be classified together under a Section set apart for the purpose. They will be placed at the opening of the Sections to which they respectively belong, and consequently will not need to be sought elsewhere. We invite comment from our readers on the magazine generally and shall always acknowledge the source of any suggestion which warrants our adopting it.

Nikola Tesla as Revolutionary!

THE electrical world owes so much to the genius of Nikola Tesla that it cannot afford to pass unheeded any pronouncement he makes as to future developments in electrical science. To the columns of the *Electrical World and Engineer* he recently contributed an extraordinary statement regarding "wireless" power transmission. Over four closely printed pages his arguments extend; first in support of world communication by wireless telegraphy; secondly, in detail of a dirigible torpedo, and, thirdly, in passionate delivery on the transmission of electrical energy without wires. Mr. Tesla is certainly not resting on his laurels or a fame which might content many men. He is working quietly but doggedly at a most fascinating problem, and judging by what he says (he comes out of retirement about once a year) is certainly making progress. Last year he merely outlined the scheme he now supports with the fervour of practical acquaintance and experience. Such details as he vouchsafes to us disclose a mere skeleton of his object, but of what colossal proportions! "It is practical to distribute power from a central plant in unlimited amounts with a loss not exceeding a small fraction of 1 per cent. in transmission, even to the greatest distance, 12,000 miles—to the opposite end of the globe. This seemingly impossible feat can now be readily performed by any electrician familiar with the design and construction of my 'high potential magnifying transmitter,' the most marvellous electrical apparatus of which I have knowledge." What can be said or done to damp the zeal and ardour bursting from every line of this prophetic utterance? Evidently nothing. We must retire into our holes and go on making dynamo electric machinery and cables, and lamps, and things just the same. Most of what we do make originally germinated in the brain of Nikola Tesla, and doubtless we shall have as little objection to paying him a royalty on any other device he may invent for our benefit, as we do now.



A Question of Smell.

THE substitution of the electric tram by the petrol omnibus is not a matter of taste but of smell. Since the steam tram has ceased to rain cinders and soot into the eyes of passengers and almost poison them with foul smelling odours, the olfactory nerves of the British pedestrian have become duly sensitive, under the welcome education of the electric tram. The alarmist rumours spread by the *Daily Mail* will accordingly be treated with the utmost complacency by both the travelling public and controllers of electric tramways whether company or municipal. Our contemporary cannot be congratulated on either its foresight or its inspiration. It has meddled with a subject outside its province, and muddled it in consequence. The best answer to its unwarranted indictment against a well-established industry is, in our opinion, that published in the *Electrician* from the pen of Mr. H. M. Sayers. He advances irrefutable arguments in support of the electric tramway, chiefly on grounds of economy, speed, and safety, and makes short work of the claims for the petrol motor which must ever be handicapped

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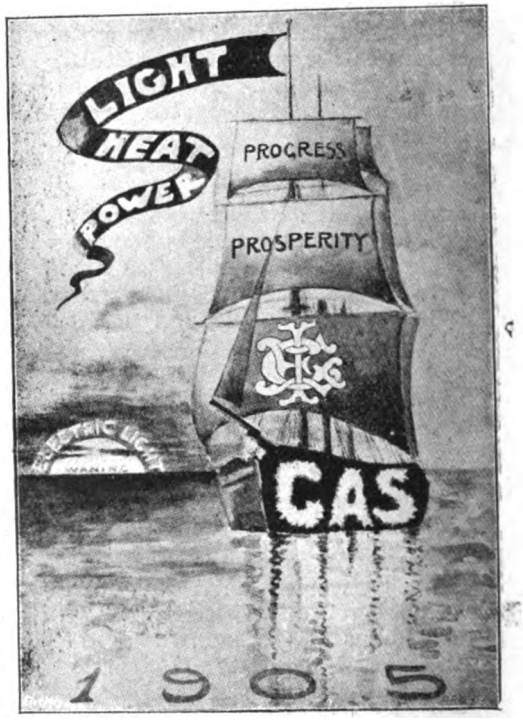
by such inherent defects as unreliability, inefficiency, and heavy prime cost. On all hands it is evident that if the enemies of the electric tram seek a pretext for condemning it they must try something more wholesome than the petrol 'bus. There would have been some excuse had they suggested an electric omnibus, as then they would not have risked being taken seriously. As it is their plaint has overwhelmed them with the ridicule they sought to heap upon other and more worthy folk. We have every respect for the motor industry, but its progeny at present cannot be favourably compared with our own, unless the public sense of smell degenerates, or it tires of a healthy method of transport.



Ships that Pass in the Night.

OUR esteemed contemporary, the *Gas World*, in contemplating the progress and stability of the gas industries, treated its readers to an "attempt at art" from one of its readers—a gas manager by the way. In this as will be seen from the reproduction adjoining, the gas interest was likened to a ship, one of the good old schooners which "braved the battle and the breeze" in days of yore. Gas is certainly an "ancient mariner," and could not be expected to embark in modern craft of steel and steam; but we do not often see so appropriate a reflection of it in its official organ as the present example. Our artist has endeavoured to portray what befell this splendid argosy on its voyage into the seas governed by Electra, and we hope its fate will be a warning to other intrepid mariners. The remarks of a contemporary (*Electrical Review*) on the same subject are worth quoting at length:

A certain well-known contemporary, whose contents are perforce "gassy," is treating the readers of its current issue to a crude pictorial effort, the exact interpretation of which is, to say the least, very obscure. To put the matter plainly, our gas friends appear to be suffering from a bad attack of "swelled head," a complaint which has been exceptionally prevalent with them since the holding of their exhibition at Earl's Court. It is possible that they have not fully recovered from the light-headed, semi-cooked, and poisoned condition in which visitors to the above exhibition escaped therefrom. At any rate, some excuse must be found for the perpetrators of the pictorial enigma described below. Picture to yourself a vessel of curious shape—in fact a "sheer hulk"—with sails bellied out to the breeze, although absolute calm reigns on the mirror-like sea; the side of the ship is illuminated with the magic word "Gas," casting, as might be expected, some local reflections. On the horizon, and half out of sight, is shown a rising or setting sun, labelled "Electric light" and "Waning," the latter word having apparently been added (not without good reason) to convince readers, against the evidence of their senses, of the

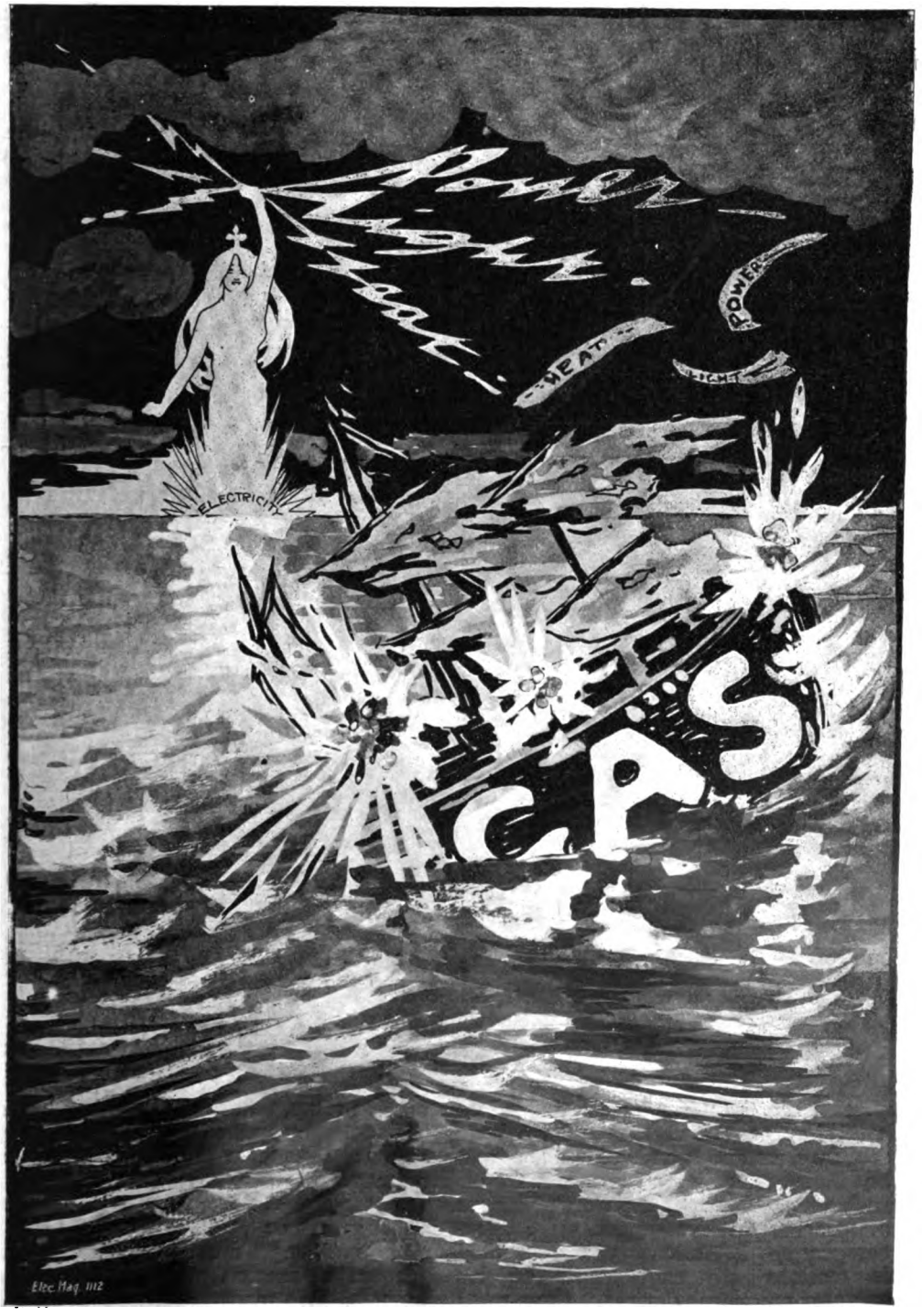


inferiority of the sun (electric light), as compared with the illuminated "Gas" ship as a source of light.

Relays or Not, Which?

A MATTER of the greatest import to the central station engineer is that of protecting his generating plant from the vagaries of operating conditions. In moderate sized alternate-current stations the fuse still does police duty, while direct-current plant when not so safeguarded is coupled through to the bars without automatics of any kind.

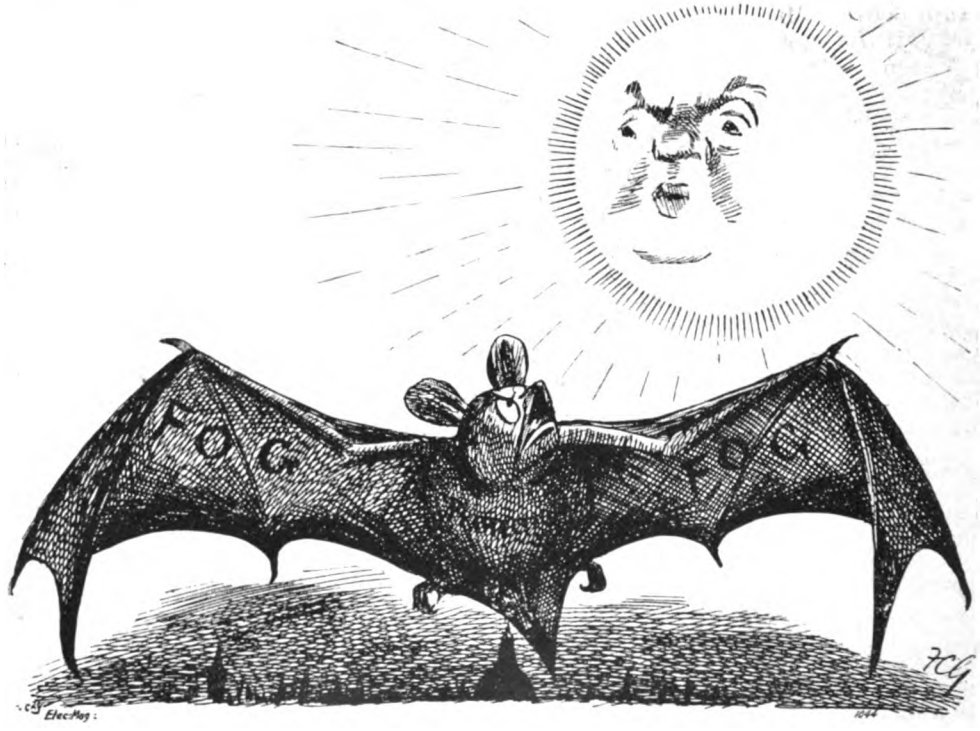
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Ships that Pass in the Night.

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Success with the overload circuit breaker originally suggested the use of a similar device in conjunction with a "no volt" coil for protecting generators, but on current reversal taking place the switch usually hung on despite the drop in volts on the bus-bars, and "the band played" in consequence. Since then automatic contrivances for protecting generators on both alternate- and direct-current circuits have come and gone or been tied up, and the dynamos have remained as defenceless as before. There have been recently signs and sounds of conflict from the Manchester local section on this much vexed question, the wordy warfare commencing with a paper on Switch-gears, by Mr. L. Andrews, who illustrated his remarks with experiments on his generator protecting devices. From what we can gather, that the proceedings at the meeting quite outrivalled those of the parent body for vivacity and interest, and that the members could hardly be persuaded to go home. Evidently the appetite of some contestants was only just whetted, as the columns of our contemporary, the *Electrical Review*, bears witness to further passages of arms between Mr. Leonard Andrews and Mr. M. B. Field. The latter opening the correspondence, stated a specific condition which shall form the controlling principle of an alternate-current relay, and showed how this could be practically applied. To quote his own words: "We must provide the relay with a sample of both the main current and the supply e.m.f. . . . These samples which must be produced *in their correct phase relations* * are usually obtained by the aid of current and potential transformers. We must then leave it entirely



Sun and Fog.

SUN: *Look here, you're interfering with my Free Trade in sunshine. Those people down there can't see!*

FISCAL FOG: *You're an alien and you're dumping! I'm protecting the Gas Lighting and Electricity Industries.*

[*By permission of the "Westminster Gazette."*

* Italics are ours.

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to the relay to discriminate. If properly designed it will sift out the power from the wattless component of the current sample, compare this as regards direction, and make up its mind accordingly." As Mr. Field points out the wattmeter type relay will meet this condition since reverse current cannot exist without reverse power, and such a device will tend to operate with the smallest amount of reverse power, but will display no such tendency with the smallest amount of forward-power. Mr. Andrews in reply, accuses Mr. Field of confusing an alternating current discriminating cut-out with a reverse power relay, and proceeds to quote experiments made with his own cut-outs under assumed emergency conditions. With two paralleled alternators, one machine was shut down and its field circuit broken, in successive tests, and in each case the "faulty" machine was isolated. The safety devices were accordingly tied up and with the machines in parallel again, the field of one was opened and the rotation of the wattmeter in circuit observed. It was found that the disc rotated in a forward direction so that a cut-out depending upon a wattmeter movement for its release would not have been opened. Mr. Andrews' cut-out, meantime, had isolated the generator under these conditions, yet he concludes his reply to Mr. Field by a mysterious sentence in which he professes agreement with him that no amount of forward current should operate a discriminating cut-out. Mr. Field, in a rejoinder, is naturally surprised at this change of front, and makes short work of Mr. Andrews' arguments, though these are obviously self-contradictory. The latter who inveighed against American relays which remained in operation under similar conditions to those of his experiments, failed to cite any instance in which a generator had been wrecked when its field was opened, and it still coupled to the bus-bars. The discussion clearly minimises the supposed risks a generator runs when "left" in this manner, and it seems that as long as it remains in step, which it will do, under favourable conditions, no relay is needed to rescue it. Should it go out of step of course a properly designed relay will at once relieve it of further duty.

The Windmill.

Operated by "DON QUIXOTE"

(This will be a regular monthly turn.)

The Professional Career.

WHEN one wishes to treat any subject in a flippant and sarcastic manner, it is the correct thing to exclaim, "Sirs! it is a queer world," or, in Scotch (there is much use for Scotch in engineering), "Hech, mon! But it's a feckless warl'." I am constrained to that observation by a consideration of the business, trade, industry, science, or profession of electrical engineering. I use the five alternatives to increase my chance of a correct appellation, as no one seems to know exactly what electrical engineering really is. We are somewhat in the same position as that early experimentalist, Frankenstein, who, after evolving his monster, was at first rather pleased with it, then a little in doubt as to what to do with it, and finally most distinctly in awe of it. We start off, many of us, by considering it as a science, spending arduous days in technical schools and illuminating the votive midnight glow-lamp in adoration of Electra, fairest of goddesses (*see* our front page). Then we get into the shops, and are very soon told that young professors can be imported *ad libitum* from Germany; but that the chief functions of an English engineer are to use a hammer and chisel without smashing his thumbnail, and to swear at a navvy with force and fluency. It then, therefore, becomes an industry to us. We get into the estimating office, and cover reams of paper with tenders which never appear to induce an order, from which symptoms of commercial depression we infer that we belong to a business. We are sent out to tout for orders, to huckster and haggle about the price of a dozen glow-lamps, and we realise that we, the hope of our college, have developed into an ordinary tradesman anxious for orders and willing to give a Christmas box to a good customer. And then we hear that Jones, who was nowhere in the classes and a dummy in the shops, has become Chief-Assistant-Consulting-Engineer, and a professional man. Every state is equally transmutable into any of the others; the test-room assistant of yesterday may be an electro-technical lecturer to-morrow. There is no shape, size, beginning, or end to electrical engineering. What is it?

The answer to which is, that it is simply a joke: a vast, substantial, practical joke of which we are the butts. Taken seriously, electrical engineering is an enigma: taken smiling, it is a simple farce. Consider even the fundamental problems: how to get in, and how to get on. In order to get in—

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well in—it is unnecessary to know any*thing*. The point is, to know some*body* who is somebody. Young man, whom I may happen to be exhorting, if you are wearing yourself short-sighted and short-tempered over Kapp and Hobart, Thompson and Perry, turn, I pray you, from your mistaken course. Seek rather the company of Fake or Smiggle, of the Broom Electrical Engineering Corporation ; study their tastes in matters liquid and solid ; speciali se on their smoking concerts, that haply they, being pocket-edition potentates, may worm you into the shops, or peradventure, into the drawing-office as tracer. The way to get on is equally simple. When one considers what a large number of electrical manufacturing supply and consulting firms there are, it is obvious to the meanest comprehension that there must be a good many company directors at large. A company director on the end of a string is a most valuable asset. Even a chief engineer has his uses, although this type of person is usually too familiar with such things as " technical qualifications."

I am reminded of a story at this point. It has, of course, nothing to do with England, but comes, I fancy, from somewhere in the middle of the Arabian desert. A certain sheik was one day absorbed in prayer and meditation at his tent-door, for that he was endeavouring to reduce the cost of water per unit camel. And as he meditated, he drew inspiration from his *hookah*. Suddenly his solitude was broken by a youth of noble mien, who, appearing from the desert, flung himself at the old man's feet, saying, " Oh, Sheik, glorious as the sun in the midst of the heavens, mighty as the sandstorm that buries the camel, wise as the Sphinx that knoweth the mysteries of Egypt, live for ever ! " And the Sheik took another puff at his *hookah*, for he had heard that sort of thing before. And the youth proceeded, " Lo, thy fame and the fame of thine oxen and of thy he-goats and of thy camels, have spread even to the land from which I came, to the land of Nubia, and lo, I am come a long journey to beseech thee to give me a place among thine hired servants, for to be an under-camel-keeper for thee is better than to be a prince of many palaces." And the Sheik grunted, for he was not disposed to pay high wages. And the youth went on : " Verily, in mine own land have I won no inconsiderable honour, for I have studied the writings of the sages, and am a Licentiate of the Board of Agriculture and various other things ; likewise have I toiled in the fields with mine own hands, and have tended the flocks in season and out of season."

And the Sheik arose and made answer, " Cast thine eye over the sand of the desert, to the East and to the West, to the North and to the South, and tell me what thou seest." And the youth made answer, " I see tracks as of many men going and returning." And the Sheik replied, " I perceive that thou art a youth of discernment, for many men have come to me desiring that which thou desirest, and many men have returned to their homes by the way they came. Go thou likewise unto thine house and unto thy kindred." And the youth turned to go, and was in sore distress. But as he went, the Sheik called again unto him, saying, " Tell me, I pray thee, thy name, that I may enter it upon my list of applicants." And the youth said, " I am Abasseh the son of Nuna." And the old man said, " Hast thou not a sister, graceful as the full corn, swift as the eagle, whose eyes are like unto those of the gazelle, and whose lips are luscious as the fruit of the date-palm ? " And the young man answered, " Yea, verily, she is as the dawning of the day for beauty, and all men come to bask in her radiance." Then said the Sheik, " Go now, return, and come hither again with thy sister, and if she be comely, I will recompense thee." And the youth hastened to his country, and prevailed, and returned, he and his sister, and lo, the Sheik saw that she was fair to look upon. Then said he to the youth, " Send thy sister among the maidens, among my women-folk. As for thee, thou are my head camel-keeper." And in a little while the sister married the Sheik and they lived happy every after.

Now if any one should ask me the moral of this story, I should be unable to answer him. Yet if he could manage to get a sister married to a director, it would be an uncommonly fine thing for him, wouldn't it ?

We may assume then that electrical engineering is in essence a joke from the very commencement. The point I am leading up to is, that the fiction of the " professional career " is the funniest part of it all. The cadets in our ranks make the mistake of taking their work-life with intense seriousness for the first few years, under the impression that they belong to a learned profession, and are called to dignity. They scramble for prizes at college ; they work for a quarter of their value to gain experience ; in other words, they " career." Perchance one or two disengage themselves from the ruck and soar even as eagles to the dizzy heights of professorship or borough engineering. But too often they venture into a too rarefied atmosphere for their physical constitution, and get prematurely exhausted. We older stagers are learning better. We are developing a smile ; our " career " has degenerated into an easy amble. Pegasus won't fly : he's only an ass. But even thistles are good if you have the palate for them.

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Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Power Progress in 1904.

By W. E. WARRILOW, A.M.I.E.E.

General.



THE past year has produced nothing phenomenal in power matters in any of the recognised centres of power transmission and distribution. A general toning up of constructional details in power house and sub-station equipment has proceeded, but no radical departures from standard practice are on record. Polyphase methods hold the field still, though the improvements in one-phase motors should be a warning to three-phasers of what is yet to come. Transmission voltages have been increasing by encouraging jumps, but the line insulator looms largely ahead as the limiting factor to further advances. Something may be looked for from extra-high tension continuous currents, some astonishing pressures having been reached in this field of research by M. Thury. Wherever water power is available there seems to arise the enterprise to use it, with consequent advantage to the particular country. The redistribution of industry to these hydro-electric power areas is very significant and merits attention in the high places of commerce. Each year witnesses some movement of industry, however slight, towards districts in which labour can be conducted under cleaner and healthier conditions, such as prevail with electric power. This is a matter of national import, and though the outward signs of its influence are not yet greatly evident, electric power must soon be as valuable an asset to a country as its army or navy. Where coal can be mined in quantity to an unlimited extent, its latent energy can still be transformed and transmitted as electricity, so that nations thus naturally fortunate can for a time remain in competition with countries utilising their illimitable water powers; but only for a time.

Great Britain

Records from all parts of this country evidence a healthy activity in power matters. The power companies, though youngest, claim first attention in the field, as their operations are fraught with the greatest importance. The Newcastle-on-Tyne Electric Power Company maintains a good lead, and with its railway and shipyard customers is likely to keep it. The Midland Power Corporation and the South Wales Company have both displayed considerable activity and continue to improve their load factors. In Yorkshire and Lancashire the equipment of power stations has proceeded apace, and we understand that the former is now in service, while the latter will be very shortly. On the Clyde, too, work has been vigorously pushed forward by the company authorised to supply in bulk there.

Such water power as can be transformed into electrical energy in these islands will shortly be utilised and rapid advances have been made during the past year with

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the North Wales and Scotch schemes. In both these, overhead bare wires will form the transmission line, as will also the lines of the Gloucestershire Power Company. The latter with the North Wales Company, were the first to obtain Parliamentary powers to use bare overhead conductors.

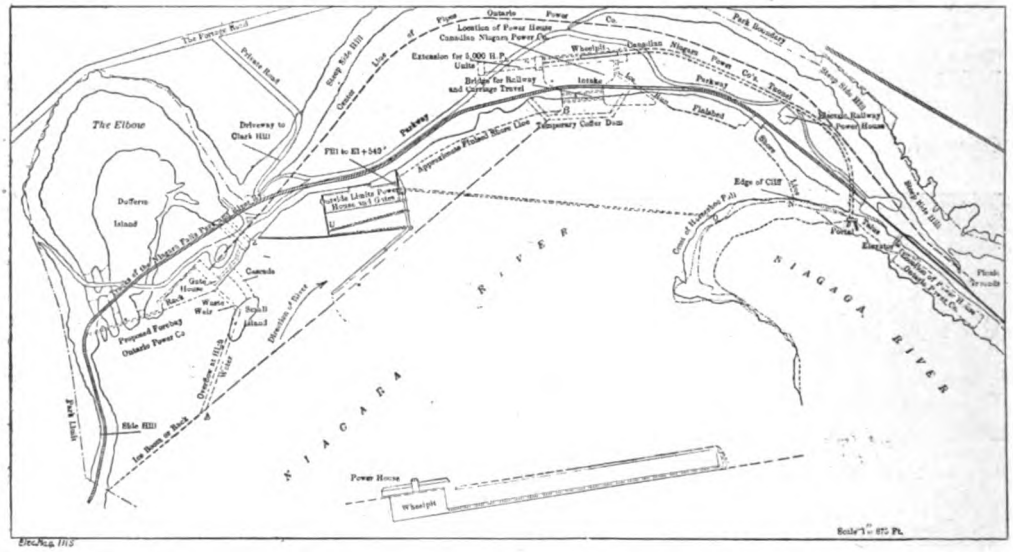
The metropolitan companies have been busy building and equipping new substations and extending old, and many large plants are supplying power in London and district, though the majority of them have an extensive lighting business in addition. The Westminster Electric and St. James's and Pall Mall Companies have "joined at" a large station at Grove Road with a total capacity of 100,000 kw.

The lighting supply authorities, both municipal and company, have also lost no time in improving their motor load and big extensions have been taken in hand in many towns, notably Sunderland, Sheffield, Liverpool, Exeter, Manchester, and Brighton. In each case polyphase plant has been installed. On the other hand, the one-phase plants have done good business in pushing ahead with their motive-power supply.

Throughout the country there are encouraging signs of an increased confidence in the electro motor and records are plentiful enough of its efficiency in every industry in which it finds a place. Special mention may be made of collieries, steel works, textile mills, and manufacturers' works.

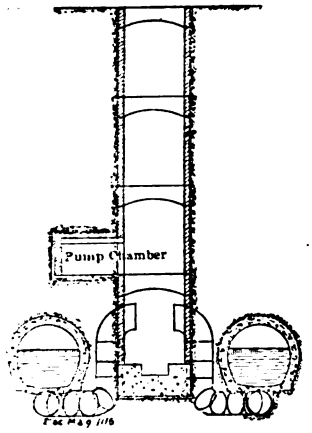
Continental.

France and Switzerland have been most active in erecting hydro-electric plants, notably at Avigonnet (15,000–30,000 volts) and Bourne River (36,000 volts), in the former country and Zurich in the latter. In Spain plants have been put down on the Ebro and at Bilbao, also at San Quirico and Camdemola, 30,000 volts being the highest transmitting tension. Paris has extended its large stations considerably, at Issy 400–600 kw. units, and the Metropolitan Station to cope with the increased tram service. In Budapest two large steam plants have been erected for supplying two-phase current at 2,000 volts. A 40,000-volt transmission line has been put into service in Italy. Schemes are in the air for the utilising of falls in the Vonoska region, near St. Petersburg, and engineers have evidently been casting longing eyes on the many Russian streams for power purposes, the estimated horse-power of these being put at ten millions.



PLANTS OF CANADIAN NIAGARA POWER COMPANY AND ONTARIO POWER COMPANY AT NIAGARA.

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CROSS-SECTION OF WHEEL PIT CANADIAN POWER COMPANY.

American and Canadian.

These two countries almost require separate treatment in power matters, for their virility in this field is not to be surpassed in any other part of the globe. In the west especially some really astounding developments have transpired, and what the engineers among the Rockies do not know about hydro-electricity, its generation, transmission, and distribution, would not seem to be worth knowing. Notable progress is evident from the published records, and now that transmission voltages are settled, attention has been turned to the introduction of certain refinements, though in reality these are necessities. Chief among these is the parallel operation of power-plants, perhaps a hundred miles apart; not one or two, but upwards of a dozen stations are coupled in multiple with the most beneficial results. The risk of shut-down is practically nullified and the combination if run with judgment and care renders the service independent of water shortage. Plants affected in this way can remain out of service while "the network" is still kept supplied, taking up the load again coincident with the return of water. The practical abandonment of the lightning-arrester on plants above 40,000 volts is an instance of the removal of a "refinement" of another sort. At the St. Louis Congress this policy came in for strong comment, not unmixed with strong language, but the "Westerns" held their ground, that the higher the line tension the fewer should be the lightning arresters.

A discordant note was struck, at the Monterey Convention of the Pacific Coast Association, in a paper eulogising one-phase working which in veiled terms hinted at the return to the pioneer method of supply at no distant date. This opinion coming from the home of polyphase power transmission lines is pregnant with conjectures as to the trend of future developments in the Californian region. The men in charge there seem too hardheaded to let a chance slip and this incident points either to dissatisfacion in the polyphase method or a perception of its being ultimately discarded for its at present subordinate rival.

In the Eastern States and Canada power stations are planted almost like trees; at any rate, they seem to flourish like the proverbial green bay of that genus. The two large groups at Niagara delivering some 128,000 h.p. are running fully loaded, most of the energy being supplied locally. On the Canadian side several great works are in progress which when completed will raise the total capacity of hydro-electric stations there to 530,000 h.p. The Canadian Niagara Power Company completed two of its 10,000-h.p. units and have recently run them up to speed.

The total output of hydro-electric plants installed to date throughout the world is estimated at one and a half to two million horse-power.

Electric Plant in Breweries.

By L. RAMAKERS.

NEARLY all the large modern breweries nowadays possess their own power stations for the generation of the electric current required for lighting purposes and also for driving machinery of various kinds.

The peculiar conditions prevailing in the brewing industry have resulted, as might have been expected, in the electric light getting a footing in this industry very promptly; in fact, it has recently shown itself to be quite indispensable. The high percentage of moisture contained in the air in cellars, brewing-rooms, and other working departments of breweries—and finally, the fact that artificial illumination is almost a *sine qua non* in such rooms, which are mostly inaccessible to the light of day—have caused very exacting demands to be made in this respect, which the electric light is solely in a position to meet in a satisfactory and reliable manner. Its advantages may be regarded as sufficiently well known for some time past; it will therefore be unnecessary to enumerate

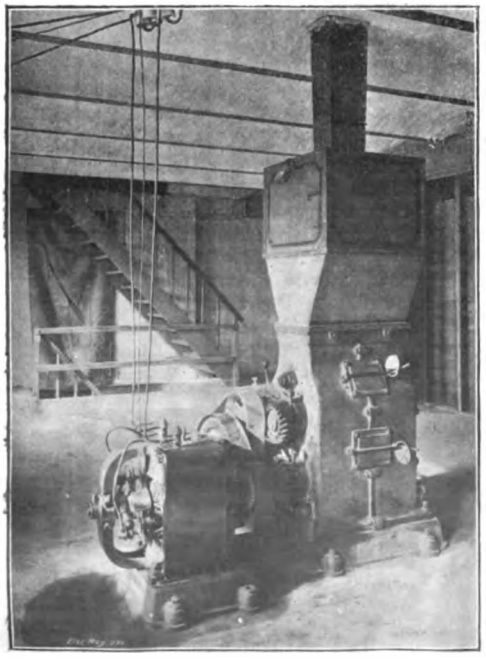
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them individually, or detail the different types of lamp.

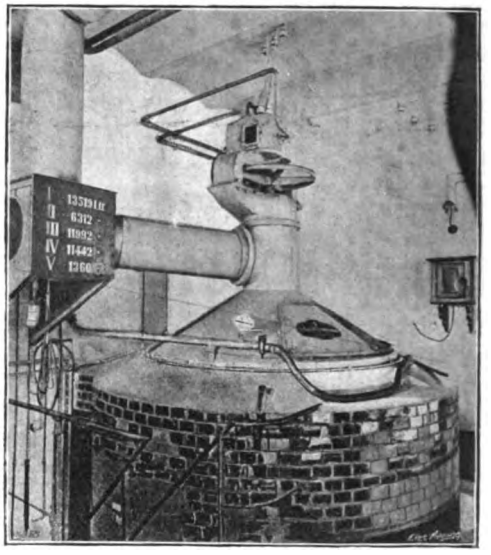
Another circumstance which acted as a favourable factor in connection with the introduction of electricity into breweries—not only for lighting purposes but also for operating the numerous machines of all kinds required—was the relative ease and cheapness with which the plant required for the generation of the electric current could be installed even into breweries of the most modest dimensions.

In most cases a plant of steam-engines was already in existence, and could thus be used for the direct driving of the dynamos. This in itself caused a considerable reduction in the first cost of installation. When the source of current for lighting purposes had once been established, then the use of electric power for other and more active purposes soon resulted as a matter of course. The great progress made of late years in connection with the construction of electro-motors, the increase in their efficiency, their absolutely ideal adaptability, to the most varied requirements even in connection with the most complicated industries, and also the reduction in sale prices rendered possible by the introduction of manufacture upon a large and cheap scale, are all factors which soon dispelled the doubts which, at first, cropped up here and there as regards its economy.

An advantage of special importance in connection with breweries is the possibility



Motor-driven Grain Elevator.

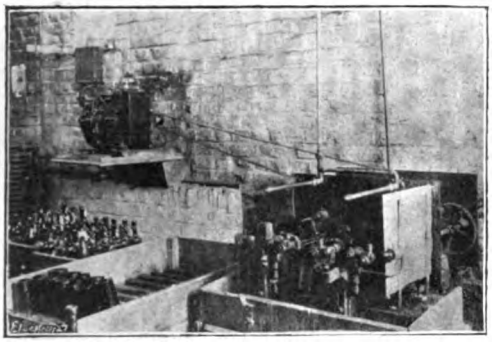


Motors Mounted over Mash Tun

(when electro-motors are used) of working all the machines individually if required. All shafting, belting, cordage, and the like—which took up a lot of room and shut out light—can be almost entirely dispensed with; while shafting-pits, with their attendant dangers, are abolished, as the putting up of the machines no longer requires to be governed by the working conditions, but solely by the questions of efficiency and—which is of special importance on the score of economy—of the consumption of power and oil. Further than this, the wear and tear of continually running shafting, to drive machines only used at intervals, is done away with, as the electro-motor only need take power according to its load. Most of the mechanical plant required in breweries would, it appears, be adapted for cheap driving by means of a separate motor. The driving is then effected either by means of belting without the use of intermediate gearing, because it is possible to adapt the motor speed to the actual working conditions within certain limits; or else in other cases when high-speed engines are used the motor can be coupled to the engine direct.

The first-mentioned method of driving is used for barley cleaning and sorting machinery, for pneumatic germinating apparatus and for exhausters, germinator cylinders and agitators. It was tantamount to Germany's duty—as she is the cradle of the brewing industry—to be the leader in adopting a process whereby it became possible to use electric energy in connection with the production of beer. As a matter of fact, this idea has now been put into practice, nearly all the leading

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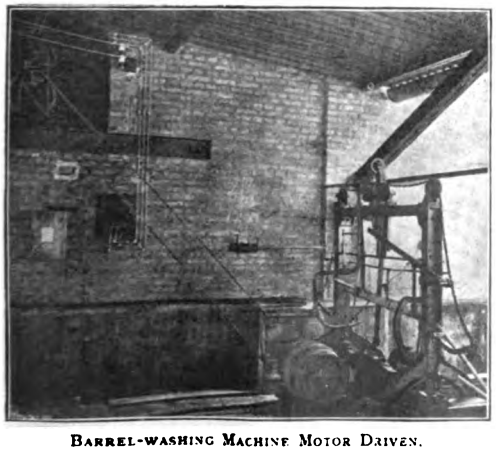


MOTOR DRIVING BOTTLE-WASHER.

Bavarian malt-floors and breweries having been fitted with electric plant supplied by Messrs. Siemens-Schuckert Werke of Berlin. According to particulars and reports to hand, this apparatus is working in a perfectly satisfactory manner.

An Electrically Equipped Newspaper Office.

A STRIKING example of the extent to which large establishments are coming to depend solely on electric power is furnished by the handsome new offices in Edinburgh into possession of which the *Scotsman* entered recently. In a newspaper office especially, electricity has great advantages over all other forms of motive power. The requirements of a modern daily journal are variable in time and amount; the maximum power, as a rule, is required only for short periods each day; it may fall to zero or rise to the full capacity almost a ta moment's notice; each section of the plant must be capable of being worked independently without waste of power. All these demands electricity meets, and therefore Messrs. John Ritchie and Company when they set about the erection of their new premises in North Bridge Street fully six years ago resolved to dispense with steam and to trust entirely to electric power alike for running their linotype machines, for working their stereotyping plant, for driving the huge Hoe printing presses, and for the many other purposes of a large newspaper office. This resolution was in keeping with the determination which the firm have set before themselves from the outset—that their offices should be as complete and as well equipped as time, money, and forethought could make them. Two small rooms in the High Street were sufficient to produce the small sheet which made its appearance weekly in 1817; the new offices in Cockburn Street, which were occupied in 1864, were regarded as preposterously in excess of the requirements; and yet long before the resolve to quit them was finally made they had become—in spite of frequent extension—far too small. This was not surprising when it is remembered that in the forty years indicated the weekly output from the establishment increased fivefold—from 170 columns of print weekly to 878. When the Town Council of Edinburgh undertook the rebuilding of the North Bridge and the widening of North Bridge Street, its southern approach, the proprietors of the *Scotsman* purchased the whole of the surplus ground on the west side of the street for £120,000. This gave them an admirable site, near the public offices, including the post office, and what was perhaps of equal importance, overlooking the Waverley Railway Station, so that by making a siding below Market Street it is now possible to bring the railway waggons laden with paper, coal, &c., direct into the stores in the basement. The building which the proprietors have erected will be a notable addition to the architectural features of Edinburgh. The sloping character of the ground entailed a large amount of excavating and blasting of solid rock, and the triangular shape of the site also made the work of the architects difficult, but they have succeeded in designing a building which is not only admirably adapted for its purpose but presents a striking appearance as seen from Princes Street and Gardens. Facing eastwards to North Bridge Street for about 350 ft. there are four large blocks of buildings which have been let as shops and offices, though, of course, they will be available for future expansion of the various newspapers. The *Scotsman* office proper occupies the north-east corner, the north frontage from the level of North Bridge Street to that of Market Street, which is fifty feet lower, and that of the railway, which is thirty feet lower still, and the west frontage to Fleshmarket Close. On



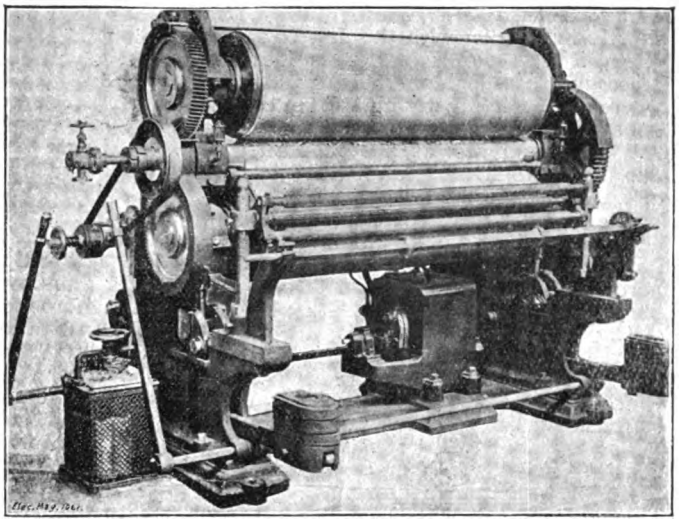
BARREL-WASHING MACHINE MOTOR DRIVEN.

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the level of North Bridge Street is the advertisement office, a palatial room panelled with solid mahogany and having massive pillars of white dark green marble. From a balcony off the street are reached the counting-house, and proprietors' and manager's rooms, which, like the large entrance hall, are panelled with Italian walnut ornately carved in the Georgian style. Out of the hall there is a broad stair of Sicilian marble with solid unpierced balusters of Pavonazzo marble enclosed in frames of dark green Verde Antico marble. The walls of the staircase are of the same marbles, and the light streams in through a leaded glass window which bears a characteristic Scottish design with the crests of the principal towns. This stairway leads to the editorial department of the *Scotsman*. In the west wing is a large room for the sub-editors, who are in touch on the one hand with the editor and the leader-writers, who occupy a suite of rooms elegantly wainscoted in oak in the Jacobean style, and on the other with the telegraph room, where for twelve hours each night the office is in direct communication by three wires with the Fleet Street office. Lamson pneumatic tubes bring telegrams from the post office (about three hundred yards away) in less than a minute and another set convey copy and proofs to and from the linotype room, which is two floors beneath. The intervening floor is occupied by the literary and reporting staffs of the *Weekly Scotsman* and the *Edinburgh Evening Dispatch*. The latter is in immediate touch with the telephone exchange through which any outsider can be put in communication with the special department he desires. In this connection it may be mentioned that there is also a system of internal telephones, by means of which each department is kept in touch with all the others, a matter which would otherwise be difficult in so large a building. The *Dispatch* has also a carrier pigeon house, an artists' room, and a photographic dark-room. On both floors there is ample accommodation for reference libraries, Parliamentary papers, and bound volumes of the *Scotsman* which have been preserved since the foundation of the paper. The linotype hall is one of the most interesting features of the building. It is a large L-shaped room, measuring about 120 ft. each way; its area is about 9,000 sq. ft. or almost a quarter of an acre. Its bright terrazo floors, its high roof, its white-painted walls, and the abundance of light by night and day combine to make it an agreeable contrast to the dingy and dirty case-room of bygone days. The linotypes are thirty in number and each is capable of setting four distinct founts. Like all the rest of the machinery in the place, they are driven by electricity, the power being supplied by two 12-h.p. motors, either of which is sufficient to drive the whole equipment. In order to avoid contamination of the air by the fumes of melted metal, each machine has a hood over the metal pot, which is connected with a system of exhaust ventilation worked by an electric fan. Part of the stereotyping being done on the linotype floor, it is unnecessary to send down to the casting-boxes on the floor below anything more than the matrix. The lighting of the linotype hall has been very successfully carried out. In addition to the incandescent eight-candle lamp which each man has at his machine or desk, there are a number of arc lamps which, though not visible to the eye from below, cast their rays on a white screen which reflects them downwards, thus producing a clear cool white light almost without shadow. There are also a number of Nernst lamps for occasional use. The stereotyping machinery for boring and trimming the plates is driven by a line of shafting operated by two duplicate 6-h.p. motors, either of which can be used independently. The printing equipment consists of five Hoe presses—two quadruple machines, two four-reel, and one two-reel. Each stands on its own pit made of glazed brick and carefully drained and heated. The five are capable of producing 216,000 eight-page papers per hour. Each machine is driven by its own electric motor and has its own starting and controlling gear complete. A powerful lift, driven by electricity, brings the heavy rolls of paper either from the store on the floor below or direct from the railway-truck at the siding two storeys below the machinery hall level, and there is an overhead railway by which the webs are conveyed to the particular machine at which they may be required. In the centre of the machinery hall is the main distributing board, from which the power circuits are controlled. A smaller board serves to distribute the lighting circuits throughout the building. Elaborate plant has been laid down for ventilating purposes. Two electrically driven fans, eight feet in diameter and capable of discharging 70,000 cubic feet of air per minute, pass the air through a coke-filter, where it is washed and purified, over steam-coils by which it is heated, and thence through ducts which lead to every room of the building. Adjoining the ventilating chamber are two Roots blowers driven by motor, for supplying the power for the pneumatic tubes already mentioned. In the lower basement are the boilers which supply steam for the only purposes for which it is required—for the heating apparatus—and provide hot water for the lavatories. The motors were supplied by the Bullock Electric Company, Cincinnati, Ohio, and Bruce Peebles and Company, Ltd., Edinburgh. Messrs. Dunn and Findlay were the architects

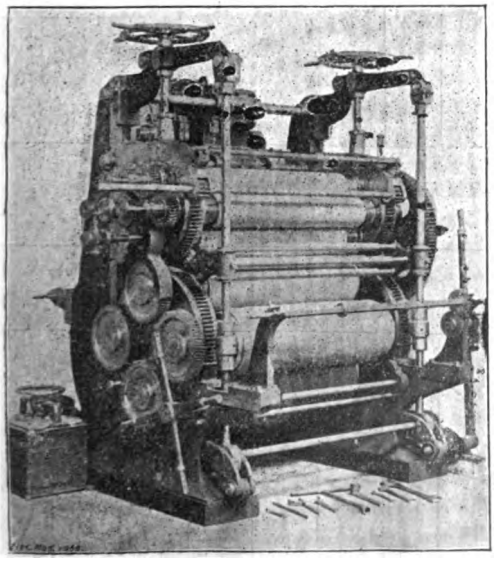
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THE ELECTRICAL OPERATION OF PAPER MACHINERY.



LARGE PAPER MILL OPERATED BY ELECTRO-MOTOR.

CERTAIN kinds of manufacturing machinery, for instance, the rotating cylinders used in the paper industry and similar apparatus, require to be driven at speeds which must be made to vary with the nature and thickness of the manufactured product. Though the required range of speeds may be very broad, yet in all cases a suitable speed once obtained should remain constant in spite of load fluctuations. All the above conditions are best met by electrical operation for such machinery, and this solution further presents the advantage of providing a gradual and continuous variation in speed, which is not procurable by stepped speed cones or change-gear systems. Speed regulation for electro-motors can be obtained in many different ways. By inserting resistances in the motor circuit, which reduces the speed by lowering the supply voltage and is, therefore, the source of much loss of power. By providing two windings on the armature and with a suitable rheostat, any required speed can be secured, but then at every change complicated connections would have to be made and broken, and this would be detrimental to smooth and proper working. A good method, which is employed by the Lahmeyer Company of Frankfort-on-Main, consists in regulating the speed by varying the field. By combining this with the use of two or at most three sets of pulleys, a very broad range of speeds is obtained, which is absolutely continuous from high to low speed. The accompanying photos illustrate some machinery which has been constructed on these principles. In some cases the motor-shaft bears a two-stepped speed cone, power being transmitted by a belt. The method can, of course, be successfully applied not only to paper machinery but also to lathes and other machine-tools.



MOTOR-DRIVEN PAPER MILL

POWER-PLANT OF THE VARESE (ITALY) RAILWAY AND TRAMWAY COMPANY.

THIS plant supplies the neighbouring districts with lighting and power current and will also serve the contemplated railway line of Varese and Varese-Prima-Capella, extending between the towns of Varese, Lareno and Luino, over a district nearly fifty-five miles in length, the water being available just in sufficient quantity for the present purpose. The power-plant includes two large stations, one situated north of Luino, near Moccagno, and the other southwards, near Ferrara. In Moccagno the water of the Giona and Casmero mountain streams is used. The dam is 24 ft. in height, and has foundations of concrete, its breadth at the foot being 21 ft. and on the top 6 ft. The pipe conduit is 265 yards in length with a gradient of 140 ft. In addition to the con-

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duit so far completed, another is to be built shortly in parallel with the first to serve as reserve. The power station is located at Moccagno, a village on the Lago Maggiore, where the conduit terminates into a distributor feeding four Pelton wheels; these will yield 500 h.p. at 360 revolutions per minute, at 46 ft. head and with 90 gallons of water per second.

The turbines of the exciter-dynamos have an output of 40 h.p. at 800 revolutions per minute. The generators are mounted on a horizontal turbine-shaft; and deliver three-phase current at 6,500 volts, 48 cycles.

The other central station is at Ferrara on the railway track now building The waters of the Margorabbia with the small lake of Ghirla, which has been developed into a high reservoir by means of a dam, are used there.

The Ferrara central station has likewise been designed for four turbo-generators, three of which have now been installed., These are Pelton wheels of 370 h.p. each, the speed being 480 revolutions per minute, the head 34 ft., and the amount of water 90 gallons per second.

The electrical part of the central station has been supplied by the General Electric Company, and the generators give 270 kw. at 6,500 volts.

OVERHEAD MAINS.

We see very few overhead mains in this country and until recently the Board of Trade would only sanction their use for special purposes and comparatively low pressures. Now, however, they permit overhead bare lines for transmission work, and this circumstance adds value to Mr. G. L. Addenbrooke's paper recently read before the Institution. The information imparted is, in many ways, valuable though it might have been compressed into about half the space. A table comparing the costs of overhead and underground is its chief feature, and we reproduce it herewith feeling that it will come in for constant reference. The extra cost of underground mains is thrown into great relief, and from it we may gather that if transmission by the power companies is undertaken with the overhead wire their financial prospects will be much improved by the lower capital cost entailed.

OVERHEAD MAINS.—THREE-PHASE CABLES.

On the Basis of 1 per Cent. Loss per Mile.

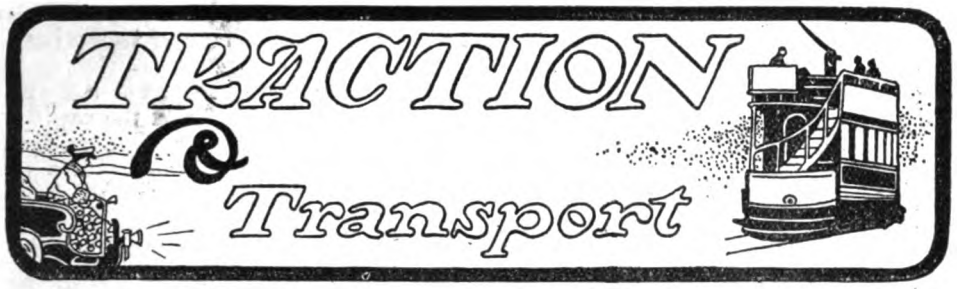
Particulars of the Conductors.			Carrying Capacity in Kilowatts at the following Voltages.				Capital Cost of Line complete per Mile, allowing 45 Poles per Mile at the following Voltages.				Capital Cost of Line complete per Kilowatt conveyed per Mile at the following Voltages.			
Size of Cables.	Section of Cables in Square Inches.	Weight per Mile in lbs.	6,000.	8,000.	10,000.	12,000.	6,000.	8,000.	10,000.	12,000.	6,000.	8,000.	10,000.	12,000.
							£	£	£	£	s. d.	s. d.	s. d.	s. d.
3— 7/18	3/.01292	3 × 266	81	152	225	323	211	230	245	260	52 0	30 0	22 0	16 0
3— 7/16	3/.02299	3 × 468	143	254	400	545	259	275	290	305	36 3	21 8	14 6	11 3
3— 7/14	3/.03588	3 × 730	222	394	615	887	301	316	332	347	27 0	16 0	10 9	7 10
3—19/16	3/.06247	3 × 1270	382	680	1,060	1,526	402	418	433	448	21 0	12 4	8 2	5 10

UNDERGROUND MAINS.—THREE-PHASE CABLES.

On the Basis of 1 per Cent. per Mile,

Particulars of the Conductors.			Carrying Capacity in Kilowatts at the following Voltages.				Cost of Main complete laid and jointed at the following Voltages.				Cost of Line complete per Kilowatt conveyed per Mile at the following Voltages.			
Size of Cables.	Section of Cables in Square Inches.	Weight per Mile in lbs.	6,000.	8,000.	10,000.	12,000.	6,000.	8,000.	10,000.	12,000.	6,000.	8,000.	10,000.	12,000
							£	£	£	£	s. d.	s. d.	s. d.	s. d.
3— 7/18	3/.01292	3 × 266	81	152	225	323	490	540	678	800	120 0	71 0	60 0	49 6
3— 7/16	3/.02299	3 × 468	143	254	400	545	520	635	725	870	73 0	50 0	36 0	32 0
3— 7/14	3/.03588	3 × 730	222	394	615	887	545	660	772	950	49 0	34 0	25 0	21 0
3—19/16	3/.06247	3 × 1270	382	680	1,060	1,526	760	853	957	1,050	40 0	25 0	18 0	13 9

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A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

A Year of Electric Traction.

By MERCURIUS.



THE greatest excitement has prevailed over the one-phase motor in the American and Continental electrical "hives" during the past year, to the accompaniment of much buzzing and humming. Formulæ, curves, tables, diagrams, and designs have come flying from all quarters, and that hitherto much maligned motor seems now to be crowned with glory. The pace was set by the Italians late in 1903, and the effect of Finzi's now historic Milan experiment on the American contingent was little short of startling. That motor might have been ready behind the scenes waiting its cue to come to the footlights! It seems now to have given place to some other "turn," as we only hear the echoes of the strident tones which hailed it before the public. Can the voices be the same which announced this Goliath of electric traction eager for battle and now summon railway men and consultants to the fray? We must at present be content to keep one eye on the single-phase experiments in Switzerland, Germany, Schenectady, and Pittsburg, not forgetting Trafford Park and Rugby, and the other on—well, the mono-rail or the tetrahedral kite!

Heavy Electric Traction.

The tastes of the British railway companies have varied during the past year in rapid transit matters. Two have electrified important suburban stretches, and a few trespassers as well, a third has a predilection for petrol-'buses, a fourth is considering the matter, and the rest are "sitting on the fence"—sitting tight, too, small blame to them. The average railway engineer in these little islands has too good a reputation to keep up to look at these gimcrack schemes of electrical men, at least so he thinks. He has staked his all on sound, civil, and mechanical engineering, and will not readily relinquish the notion—it is sheer cussedness—that trains cannot be run with overhead wires and such-like flimsy paraphernalia, and compete with his steam locomotive. He wants to keep his existing system intact and run it with storage-battery locomotives, doubtless. We must not forget one thing: his finance is not controlled from Wall Street in common with such small fry as electrical manufacturers, and that makes all the difference.

The results of operating the third-rail lines of the Lancashire and Yorkshire and North Eastern Companies should make interesting reading if they are ever made public, though both will reap considerable benefit by the change. Other companies will not, however, be likely to follow suit even if large profits were made. They are evidently kept well informed of the state of the electrical atmosphere, and will act only when they can see well ahead of them.

Tube lines have been busy burrowing under London and bid fair to be well agog before the Traffic Commission presents its report. With motor-'buses in the city, trams on the Embankment, and tubes below ground, that Commission wi'l

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wonder why it has laboured through so much to gain so little. The Metropolitan and the District Railways have vied with each other in their haste to electrify themselves and their passengers, but the former has got the lead. Meanwhile, Lots Road power house has been rising and filling, and cables and third-rails have been going down.

In America the interurban electrics have competed keenly with local steam lines, and given a good account of themselves. Public convenience is evidently held sacred, for in some cases the "steamers" have made arrangements with the electric lines to take up goods from them. In other instances the locomotive has got fairly beaten, and the rival line has amalgamated or "gone bust." The methods of these lines are worth watching by tramway men over here, as many a valuable hint is dropped in their published records and only waits picking up. In operation, these interurban systems present quite unique features. Power is generated wherever conveniently adjacent to the routes, either by water or steam, and transmitted to a regular string of substations. The power houses also are operated in parallel on the line. In the expansion of these linking systems the compensated direct-current and alternate-current motor will doubtless be used, and the long-distance car will then start in the heart of the city, and not on the outskirts.

In and around New York City, traction events of great import have been and are happening. The New York Central and the Pennsylvania Railroads are doing big things with heavy electric traction, and their methods should not escape the notice of the railway companies over here. The former has incidentally marked quite an epoch with its unique electric locomotives, the motors of which are mounted direct on the driving-axles. This construction will extend the life of direct current for traction work indefinitely, and keep it up against alternate currents in spite of itself. The Pennsylvania Company in its efforts to get passengers in and out of New York across the Hudson and East Rivers, is boring beneath the latter and rising to the surface at Manhattan to the Grand Central Station; the trains in the tunnels will all be electrically propelled as a matter of course. The volume of traffic handled by both these companies testifies to their confidence in the superiority of the electric locomotive over steam and the rapid progress of the work shows a desire to operate under improved conditions with a minimum of delay. The line of lakes and waterfalls forming the north-eastern boundary of the United States has prompted proposals for operating trains between New York and Chicago, by the electric power derived from these sources, but at present these are only proposals.

On the Continent honours are about evenly divided between one- and three-phase as far as long-distance traction is concerned. The former has been used on the Spindlersfeld line and is being put down on tracks in Switzerland and France. The Valtellina three-phase line has been taken over as successful in every way for long distances, but at one time there were rumours of its being "single-phased." Beyond extensions of the Paris Metropolitan, which has survived several fires and one panic, nothing more of importance is to be recorded from the Continent.

Light Railways and Tramways.

There was a good crop of tramway and light railway schemes put into operation last year in this country, and with undoubted benefit to the travelling public. Groups of townships are displaying remarkable tramway affinity and several important systems linking prosperous communities started running last year. A feature of one of these—Stalybridge, Hyde, Mossley, and Dukinfield—was the exceptional unanimity displayed by the authorities of the different districts. A joint board was appointed and a fine scheme hit upon to supply the entire twenty-one miles of route from a single power-station. May this good example be copied elsewhere, unless the local power company (if existing) be given the contract for the requisite power. Other districts opened up are Wakefield, South Lancashire, Tyneside, and the four quarters of London's suburbs. The latter can now boast many splendid systems, and the more recent in North London are supplied on modern lines from turbine-driven units. Of large towns now blessed with electric trams, started during 1904, notable examples are Leicester, Preston, Bury,

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Barrow, Darlington, Northampton, Colchester, and Swindon. In each case the ubiquitous trolley-wire is used. Conduit traction seems confined to London and Bournemouth, and surface-contacts to Wolverhampton, though they are to find a way into Lincoln and Torquay.

So much for construction; in the operating field there are still many financially unsuccessful undertakings and as many critics, locally and otherwise inspired, ready to fall upon these unprofitables and rend them.

America is laying electric trams everywhere, without even considering if motor-'buses are better, and visitors from this side to the Congress evidently learned how track should *not* be laid and overhead wires slung.

They do things differently on the Continent, and from all accounts many new lines have been laid, while the old ones have had substantial extensions tacked on to them.

In the Colonies a spirited interest has been displayed in electric traction, which has further been backed up by enterprising action, and such places as Mandalay and Hong Kong have now a good car service.

Since the above was written the *Daily Mail* has been treasure-hunting. It has discovered £60,000,000 sunk in electric tramways in this country and called in an anonymous expert to tell it and its readers that this is all lost. It is now searching to recover it in motor-'buses. When the air is blue we shall be happy to send an electro mobile to join in the quest.

The Third Rail and its Protection.

By FRANCIS H. DAVIES.

THE comparatively large number of accidents which have followed the introduction of third-rail electrical lines in this country, besides having created some little stir in the lay press, has been much commented upon in engineering circles, where the fact is generally recognised that the third-rail system is earning not only a bad name for itself, but is giving rise to much misapprehension in the public mind upon electrical matters in general. To what degree these unfortunate occurrences will militate against the adoption of electricity for railway work remains to be seen, but that they will have a deterrent effect, if only a temporary one, is much to be feared.

The exigencies of modern life have forced upon us many ways of doing things that our forefathers would have characterised as the very acme of madness, and the town dweller nowadays, and to a certain extent the countryman, lives in an atmosphere of danger that by long use he has come to regard as part and parcel of his everyday life. Doubtless by a similar process of evolution he will become as accustomed to third-rail electrocution as he is to being asphyxiated by gas and run over by motor-cars; but in this, as in everything, evolution must be a question of time, and in the meanwhile, should such fatalities continue, there is every reason to apprehend a strong revulsion of public opinion against the third-rail system, with the possible result of a serious set-back in the much-to-be-desired direction of railway electrification.

That engineers have long recognised the potential danger of a bare 500-volt conducting rail is evidenced by the way in which they have striven to protect it; with what success may be gathered from the following drawings indicative of the methods employed by sundry electrical lines. Fig. 1, that of the Mersey Railway

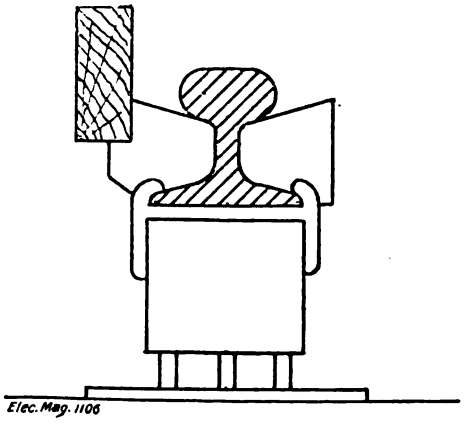


FIG. 1. MERSEY PROTECTED THIRD RAIL.

Company's is the least elaborate, the reason being that the line is short and for the most part inaccessible to the

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general public. Here, the live conductors are laid adjacent to one another between

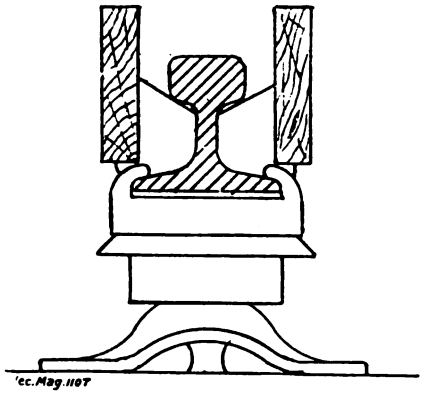


Fig. 2. Protection on Metropolitan Railway.

the two tracks, and a wooden guard running the entire length of the rail on the outside has been deemed sufficient protection for the Company's servants, who alone have access to the line. Figs. 2 and 3 illustrate respectively the Metropolitan Railway and the North Eastern Railway methods which are very similar, consisting of two boards projecting above he top of the rail so as to prevent anything falling across it from making contact. Both these lines are more subject to trespassers than the Mersey Railway and consequently the protection is better.

The Manhattan Elevated Railroad construction, Fig. 4, is practically the same as that of the Metropolitan Railway, but the New York Rapid Transit Subway, and the Paris and Orleans Railway

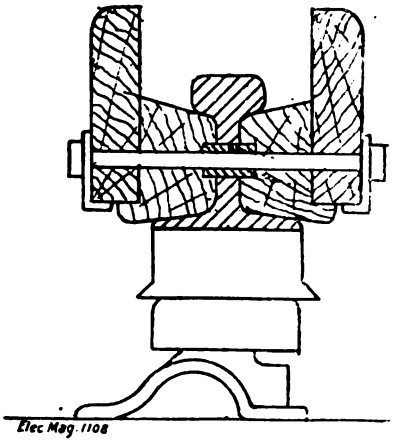


Fig. 3. North Eastern Protected Rail.

Company, go a step farther than any of the former, and provide protection for

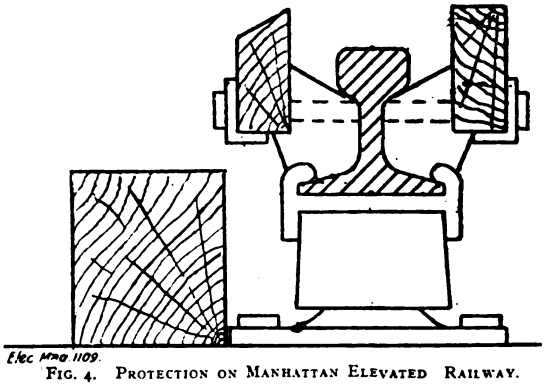


Fig. 4. Protection on Manhattan Elevated Railway.

the top of the rail, Fig. 5, and in the latter case, the side in addition, as shown in Fig. 6. This is the construction in stations, and appears by far the most efficient of any yet introduced; it must, however, be comparatively costly, and scarcely conducive to high insulation in wet weather; and setting aside the ever-present chance of ignorant or malicious interference, there still remains on this system the possibility of accidental contact, although to an infinitely less degree than in any of the others illustrated.

The lesson to be deduced is plain:

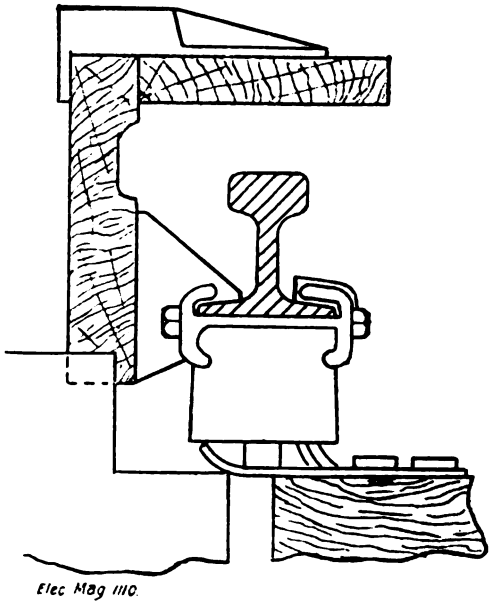


Fig. 5. Protected Rail New York Subway.

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evidently there is at present no practicable means of effectively guarding the third rail, that is, of so protecting it that accidental contact is impossible, and wilful tampering difficult; and moreover, it does not appear that any material improvement over existing methods is within the bounds of possibility. The list of accidents has proved beyond doubt that none of the present systems are efficient in even the first respect, and unquestionably as electrical third-rail lines are pushed into rural districts where the level of intelligence is not high, we may expect this list to be swelled to an alarming degree, at any rate for the first few years of operation in new

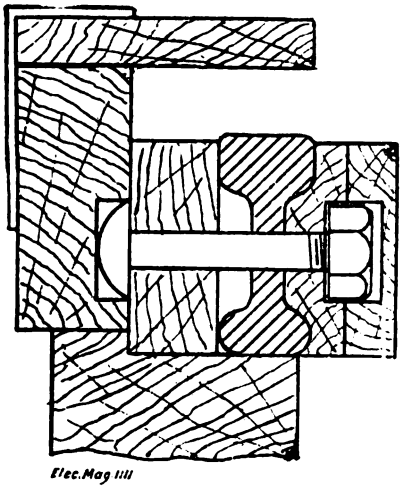


FIG. 6. PARIS-ORLEANS PROTECTED THIRD RAIL.

quarters. It is impossible effectively to fence in the entire length of any main or suburban line of importance, hence, it becomes necessary to take the trespass question into full account; and in addition, the welfare of platelayers and other workmen must be looked after.

It has been held that unauthorised persons crossing or travelling along a railway track do so at their own risk, and that the remedy for the third-rail danger is simplicity itself, namely, "Keep off;" but this takes into no account railway servants who, though presumably better acquainted with the risks to which the third rail exposes them, are by no means infallible, and may well fall victims to accident or that contempt bred of familiarity. Whatever may be the legal aspect of the question as regards trespassers it is a most decided anomaly that while spring-guns and man-traps are forbidden even when a notice is exposed warning interlopers of their presence, the third rail, which is apparently considerably more dangerous, is permitted by law with absolutely no indication of the peril that lurks between its protecting planks beyond the facts that it *is* protected, and that it stands on insulators: two points that would not appeal to the lay mind.

Much has been said for and against the third-rail system in many quarters, and it has been frequently urged that as a potential of 500 or 600 volts does not usually do any harm to electrical men, or those conversant with the possible results of such a shock, it cannot be regarded as a source of much danger to the public. Such arguments are best answered by facts; and no matter how this pressure affects the experienced man, it is indisputable that it has been the cause of death to many less versed in electrical matters.

Whether these deaths may have been due to fright or fall is immaterial; the fact remains that a potential of 500 volts caused them, and if the third rail had not been there, valuable lives would not have been lost.

In view of these fatalities, it is evidently desirable to look for some means of railway electrification that while sacrificing nothing in convenience or cost, does not introduce such an element of danger to the public at large.

An early solution was the sectional rail system that by means of automatic switches, made alive only that section of the conductor that was covered by the train; but satisfactory though it may be, and indeed has proved itself in practice, this system only minimises the risk, and in addition, increases the capital outlay. It is necessary, therefore, to go farther afield, and the latest solution of the problem is found in the overhead system which entirely does away with the third rail besides adding materially to the possibilities of electric railway traction. Main-line working by the third rail is now admittedly impracticable for economical reasons, so in any case, the overhead wire will have to be resorted

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to here in conjunction with either a single or multiphase alternating-current system; judging from the trend of recent events, most probably the former.

It is, therefore, only short local and suburban lines where the third rail is commercially possible which are likely in future to present this danger to the public; that is unless the overhead alternating-current system is found proportionately as economical for short distance and dense traffic as it undoubtedly will be for main-line work. Many who are in a position to know maintain that it will show equally as good results in this sphere, and if experience confirms such statements, then certainly the third rail will go.

At any rate it is evident that complete immunity from the risks attendant upon its use can only be purchased by its entire abolition, which of necessity means the substitution of the overhead wire.

AUSTRALIAN TRAMWAY SYSTEMS

In no part of the world, in proportion to the number of population, are street tramways more extensively used as a means of passenger transit than in the leading Australian State capitals. Although their introduction is of comparatively recent date, their development has been marvellous, and, as in many European and American cities, they have assisted in making riding cheaper than walking, and are causing the omnibuses and other conveyances of a past generation to become forgotten. In Sydney the tramways were originally worked by steam power, the cars being double-decked, like the railway carriages on several of the Paris suburban lines, but subsequently the cable system was introduced, and later on electricity became utilised as the motive-power, and with such success that it is only a question of time when the locomotive and cable will be found dispensed with. The various tramlines, which, like the railways, are the property of the State, form a complete network of communication between nearly every part of Sydney and its suburbs, and thus assist in counteracting the tendency to overcrowding which forms one of the evils associated with large centres of population. The total length of tramlines open on June 30, 1903, was 124½ miles, representing an expenditure of £3,371,587 for construction and equipment, the number of passengers carried during 1903 being 130,405,402. The Melbourne system, embracing a length of forty-eight miles, forty-three and a half miles of which are worked by cable, and four and a half miles by horse-power, was constructed by a municipal trust at a cost of £1,705,794, and is leased to a company. It is said to be the largest and best cable system in existence. The number of passengers carried during the year was 47,564,942. There are also several suburban lines worked by limited liability companies as follows: horse, 8½ miles, electricity, 4 miles; and cable, 2¼ miles. In Brisbane the tramlines were originally worked by horse-power, but in 1897 this became replaced by electricity, the tramways being the property of an English company, and covering a total length of twenty-eight miles. As the traffic increases, extensions are effected. At the close of 1902 there were in the State sixty-five miles of tramways, including those in Brisbane, the number of passengers carried during 1903 being 18,125,302. In Adelaide there are several tramway lines worked by horse-power, but an attempt is being made to secure the introduction of the electric system. The lines are owned by private companies. In Western Australia, Perth has a well-organised system of electric tramways, which, like that in the Kalgoorlie Municipalities, is the property of a private company. Fremantle and Boulder City also will shortly be in possession of electric tramway systems, constructed by private enterprise under municipal supervision. The only State-owned tramway is that running between the port of Roebourne and the town of Cossack, a distance of eight and a half miles, in the north-western portion of the State. In Tasmania the Hobart tramways are worked by electricity, and extend a distance of about nine miles. They are owned by a private company, and were opened in 1901, in which year they carried 1,432,176 passengers. There is also a steam tramway in the north-west portion of the State, connecting Zeehan with Williamsford, a distance of eleven miles, its summit being 1,500 ft. above sea-level. Compared with other Australian tramway systems, that of Sydney is considerably the most efficient, there being a continuous succession of trams from early morning until midnight, an all-night service being established on several lines. During the earlier hours of the day and in the evening the tram traffic is enormous, the cars running almost every minute and being densely crowded. It is the same at holiday time, and the greater the amount of accommodation provided by the State railway Commissioners the denser becomes the crowding. It is as if the whole population desired the use of the tramcars. Yet, with all this heavy traffic, accidents are comparatively few, being in most instances due to the disregard of ordinary precautions on the part of the sufferers.

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Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

Electric Lighting and Heating in 1904.

By PROMETHEUS.



IT is usual to take stock at this time of the year. Only in this way is it possible to draw up a balance-sheet, and to make out a profit and loss account. If asked what is the most notable advance in 1904 in the sphere of electric lighting, it is not easy to be ready with a straightforward answer. There has undoubtedly been some advance; we all know that. We shall have to look far forward into the dim and distant future before we can imagine a time in which further progress will have become so difficult that a period of stagnation is possible. But has any really notable change been made in methods, or is there any sign that any such notable change is impending? We can only reply more or less evasively. The past year will probably not be regarded in the future as having introduced any revolutionary changes; it has rather been a period of quiet evolution. Except for the magnetite arc lamp, which is at present almost undeveloped, but has latent possibilities, things have moved along the old lines; and it will perhaps be as well to note some of the more important of these moves, and to point out wherein their value may lie.

The Nernst lamp has continued to annex new territory, and to make itself known to larger circles. Probably it has made no particularly striking development during the year, but has contented itself with gradual evolution along already familiar lines. A new form of heater has been spoken of, but in England at any rate, the old spiral heater seems still to hold the field. The newer form is flat, and lies against the porcelain base which supports the filament. In this way the light is said to be less obstructed, and the heating more effective. As far as the obstruction of light is concerned, the spiral heater is a great sinner; but as for effective heating, it would appear to be better than the flat form, at least so it would seem at first glance. With the Nernst lamp, it must be confessed that the heater appears to be the least satisfactory part of the lamp. In early life, it works well enough; but if the filament becomes deformed owing to the great heat or if the parts get displaced with regard to one another owing to any cause, the lighting-up of the filament is apt to take an unconscionably long time. But perhaps we are captious critics; but this is always the fault of the consumer, who is nothing if not critical. Scientific physicists have put the temperature of the filament at 2,360° C., and have said that it has an efficiency of 4.17 per cent., that is to say the ratio of the energy emitted in the form of light to the total energy consumed is 0.0417. Future generations have therefore plenty of room in which to work, seeing that this figure represents the best commercial efficiency which has yet been reached in the sphere of domestic electric lighting. The Moore system of vacuum

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tube lighting claims an economy of 30 per cent. over the incandescent lamp, and this vague claim might put it on a level with the Nernst lamp; but judging from the description of some pioneer installations on this system, which have lately appeared in the technical press, it must be said that any such economy is more than outweighed by obvious disadvantages. With high pressure applied to every "lamp," which consists in one of the cases described of a glass tube 154 ft. long, and 1¾ in. diameter, it is to be feared that the general public will fight shy of such an arrangement with its many danger-proof boxes to which the terminals of the lamps are brought. If an ordinary office needs an illuminant of this gigantic order, it would seem as if the inventor lacked a sense of proportion, and further advance along these lines looks very doubtful. The Cooper-Hewitt lamp is a far more hopeful form of vacuum tube lighting. It has almost certainly made progress during the year, but even so it has hardly emerged from the stage in which a novelty is regarded as a curiosity of the laboratory. The colour of the light is not well suited to the requirements of social life; and though many attempts have been made to add some red rays, it now seems likely that they will be fruitless. When applied under circumstances in which the colour of the light is immaterial, it does well, and there are many conditions under which such application is possible. Moreover, the actinic value of the light emitted by the Cooper-Hewitt lamp is very high, and makes it especially suitable for photographic work, both for printing purposes and for taking exposures. Still even now too little is known in this country about the lamp for us to be able to express definite opinions; all that we know is mainly gathered from the technical press, or from an occasional lecture. Very few have any experience of the lamp in its everyday working. The candle-power, however, is known to fall off very decidedly even after twenty-four hours work, and the inner surface of the tube is said to be gradually covered with a coating which is at first grey and afterwards black. The life is long, and may possibly be put down at 1,000 hours, the eventual failure being due to gradual loss of vacuum, caused by leakage at the leading-in wires. This leakage, which is supposed to take place through the substance of the platinum wire, has long been noticed in physical laboratories in connection with vacuum tubes, though the cause was not understood. The most probable explanation is that it is due to leakage through the leading-in wire, though in the case of the incandescent lamp it does not appear to be a determining factor in limiting the life of the lamp. Another novelty about which we have heard a good deal and seen very little ought to be mentioned under this head, if only for the purpose of recording the report that it is now dead and buried. This is the osmium lamp, but whether the report is true or not we cannot tell, to such an extent are these things covered with a veil of commercial secrecy. Still it is well known that the filaments were inclined to be weak, and that their resistance was very low, two faults of the first order. They were said to be made by squirting an intimate mixture of osmium, soot, and gum solution through dies; and though the Nernst lamp forms a notable exception to the general rule, it has always been found that filaments which consist of intimate mixtures of powders glued together with gum or treacle are failures. However, we may live to see other exceptions, and prophecy is known to be the most gratuitous form of error. So we will pass on to some other aspect of electric lighting problems, merely mentioning by the way that Siemens and Halske are working on a filament composed of a mixture of thorium and thorium carbide (which sounds absolutely hopeless), and another German inventor is concentrating his energies on a filament which is made of a mixture of iridium powder and vegetable glue.

In the arc-lighting world, much has been done; but it is only possible briefly to skim over the surface. The Blondel arc lamp seems to be a variant on the Bremer lamp; but apart from questions of molten scoria and oxide vapours, the carbons burn away very fast. With a Blondel lamp taking five amperes, and having carbons ½ in. in diameter, they burn away at the rate of ½ in. an hour. The very interesting magnetite lamp, invented by the General Electric Company of America, uses magnetite, the black

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oxide of iron, as one of the electrodes. The other electrode is a copper segment, which is of such size that the heat developed is conducted away as fast as it is generated; the copper segment, therefore, never gets very hot, does not burn away, and forms permanently a part of the lamp. The magnetite electrode, on the other hand, burns away at the rate of $\frac{1}{8}$ in. an hour, and by adding a small quantity of some titanium compound, the rate of burning may be still further reduced. In fact, 8 in. electrodes can be made which will burn for five hundred hours, and the arc formed is said to be twice as efficient as the carbon arc. These lamps are already being used for street lighting in America, and we may expect to hear more of them during the coming year. Finally, mention ought to be made of Mr. Duddell's curious speculations on the back e.m.f. of the arc, which he puts down as varying between five and twelve volts with the different makes of carbons. The back e.m.f., according to his view, really consists of two separate e.m.f.s. Of these it was found by a search carbon that the larger is near the positive electrode, and opposes the flow of the current, while the smaller is near the negative electrode and acts in the opposite direction to the former.

It seems curious that electric heating should make such slow progress. Higher temperatures can be obtained by electric means than in any other way; but when it comes to heating a jug of water or roasting a joint of meat, the gas engineer and the old-fashioned fire have the field all to themselves. During the past year a new resistance material has made its appearance called Kryptol. It is a coarse powder, composed of a mixture of graphite, carborundum, silicates, and clay; it will withstand a temperature of at least 2,000° C., which is reached by passing an electric current through the powder. The material is said to be durable, but no doubt something depends on the conditions of working, as carborundum and graphite are oxidised at a red heat, and as these form the conducting part of the powdered mixture, and cease to conduct when oxidised, it is evident that Kryptol can only be durable on the assumption that a high temperature is not required. Many resistance materials have been invented, consisting of a mixture of graphite, clay, and similar substances. It is to be hoped that Kryptol will be more successful than its predecessors, which are, for the most part, buried in oblivion.

Electric Lighting in Paris.

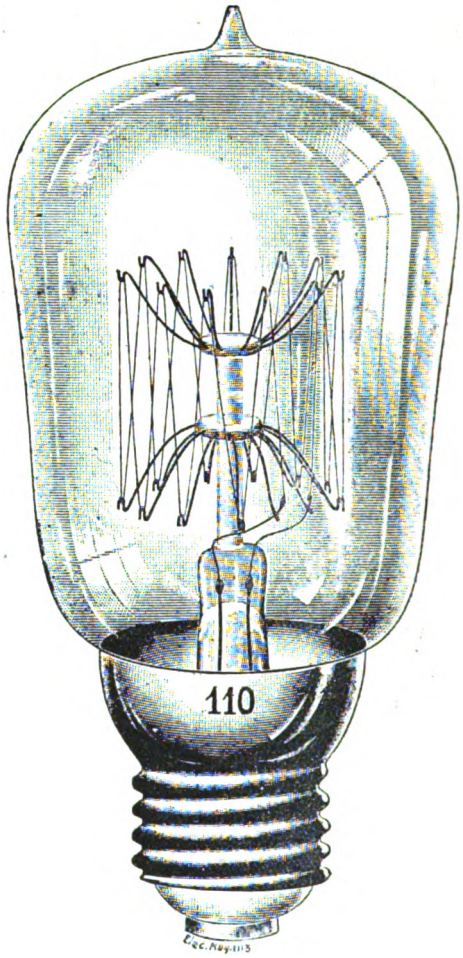
THE elaboration of a new scheme covering the entire question of electric lighting in Paris, is a problem whose solution calls for more than ordinary financial and engineering skill. Such a problem will shortly be put before the Paris municipality, and it may be of interest, at present, to take a passing review of the situation. Towards the close of 1888 the council issued specifications of the conditions required for acquiring licences. Paris was divided up into sectors of optional dimensions for which tenders were invited At the time, electricity was little in favour with capitalists, as success had not hitherto attended the efforts of those who had attempted to produce electricity on a large industrial scale, and people were not willing to launch forth into big undertakings with no satisfactory financial outcome as precedent to encourage them. However, the maximum limit of the tariffs conceded was very high, and the range a very broad one, and this induced four companies to accept specifications of which several important clauses were disadvantageous and even dangerous. The area covered by these companies extends over one half of the city, comprising the most densely populated parts. Continuous current was adopted, with 2, 3, 4, and 5 wire distributing systems. About eighteen months after this, two other companies obtained the sectors of the Champs Elysées and the Rive Gauche, and owing to the lesser density of the population supplied, adopted alternate current which is much easier to instal. At present, out of the eighteen years granted by the concession, sixteen have passed away and the financial position of the six companies is anything but satisfactory. They have been accused of scaring away consumers by exorbitant tariffs, but the ready answer to this accusation is that Paris contains twice as many customers as London and four times as many as Berlin, so that the companies can hardly be at fault on this point. Considerable sums have been invested in the undertakings and the companies were unable at any period to distribute dividends superior to 4 per cent. The distributing systems revert to the municipality at the expiration of the concession, but the companies will lose heavily by this clause if it is rigorously enforced, as they have been unable to pay dividends, and cover by the sinking-funds the outlay on plant. In

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addition to this, they have considerable plant and fixtures which will remain on their hands, and it is doubtful whether they may get rid of this without heavy loss. As the matter stands, several solutions suggest themselves for the future Paris electric lighting *régime*. One would be to put the whole plant in the hands of the municipality, a contingency provided for in the specifications drawn up in 1888, which gave to the municipality the option of acquiring the concession during exploitation. But since in this case the system would have to be bought by the city, it would be perhaps better policy to await the expiration of the concession. In that event, however, the city has no longer the option of purchase of plant on expert valuation. To secure the power houses, sub-stations, transformers, junctions, &c., the city will have to come to an understanding with the companies. Should the parties fail to agree, then two alternatives would be left open. First, to construct immediately, in accordance with the suggestions presented by eminent foreign specialists who have been consulted, and who advise the building of large power houses outside Paris, providing for an entirely new and up-to-date system, and at the expiration of a given concession, to endeavour to secure the old customers and some new ones besides. In this case the old systems would have to be taken away by the old companies. This solution would be possible though it would require a long break in the service. Secondly, to use the optional right of purchase of the whole plant on expert valuation. A third hypothesis might occur of fresh tenders being made by outsiders which the city would find more advantageous than those of the old companies, but the newcomers would experience the same difficulties as the city in regard to the long break necessary in the service. If none of the proceeding combinations succeeds, it will then be necessary to negotiate with the old companies and make new agreements. The whole problem is an extremely difficult one for all parties concerned, and if not taken in hand in a very intelligent, comprehensive, and liberal spirit, may result in two years time, in an imbroglio which will throw back, not only the whole scheme of electric lighting in Paris, but also be very detrimental to technical progress.

The Tantalum Lamp.

MESSRS. SIEMENS AND HALSKE are to be congratulated on the successful issue of their attempts at producing a more efficient vacuum incandescent electric lamp. The tantalum lamp will always remain a monument to the labours of this enterprising German house, whatever its future in the lighting world may be. The main object of the research work upon which the company started was the discovery of a metal to displace the carbon filament now common to electric glow-lamps. Investigations, in charge of Dr. W. von Bolton, commenced several years ago on metals whose melting-point was considerably over 2,000° C., and after experiments with vanadium and niobium, which were rejected as unsuitable, tantalum, of the same group, was selected. After certain preliminary trials, tantalum powder was finally taken and melted in vacuo, when it parted with its residual gases. Progress was then sufficiently encouraging to merit further procedure, and subsequently the metal was reduced to a size suitable for working into lamp filaments. At this stage Dr. O. Feuerlein undertook to get the filament into a glass bulb. The



[FULL SIZED VIEW OF TANTALUM LAMP.

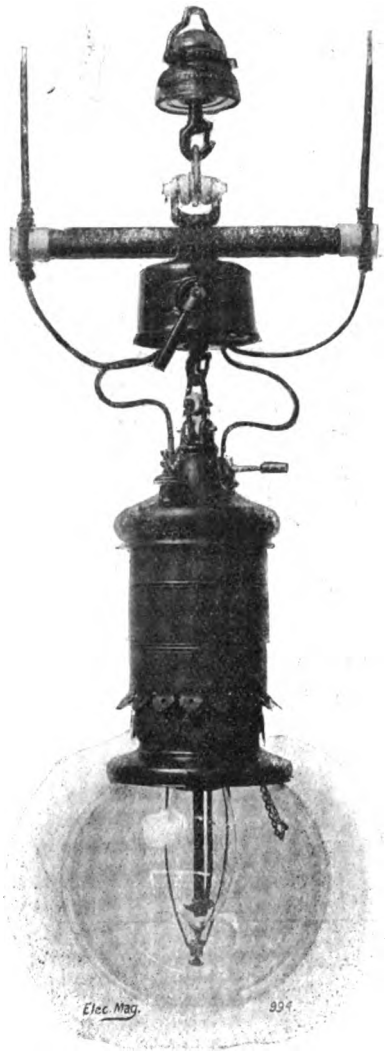
first lamp had a bow-shape filament, similar to early 100-volt lamps, about 1⅜ in. long. and required 0.58 amperes at 9 volts, giving 3 c.p. or 1.7 watts per c.p. A lamp to give the same economy on a 110-volt circuit and 38 c.p. needed a filament about 25½ in. long. To distribute this exceptional length of filament was Dr. Feuerlein's work, and after repeated trials he evolved the construction shown in the illustration. This is a standard 110-volt 22-c.p. lamp giving 1.7 watts per candle, or about half that of the ordinary incandescent lamp. The filament weighs 0.022 grams and 45,000 lamps would require one kilo of tantalum. The central support is a glass rod, at the upper extremity of which are a number of wire arms. A similar wire umbrella, but inverted, is fixed lower down the glass rod. and between these two supports the filament is strung and held in position by suitable hooks. Leading-in wires fused into the bulb connect up to the ends of the length of filament. For the same economy the lamp has several times the life of the carbon filament lamp and gives double the light for the same consumption of current. The useful life is between 400 and 600 hours, and the absolute life about 800 to 1,200 hours. As with the carbon lamp, the illumination gradually falls off to about 20 per cent. of its original value, at which point it needs replacement by a new lamp.

The appearance of this decidedly unique lamp on the market will be awaited with the keenest interest, and we look forward to testing one at an early opportunity.

A.C. Series Arc Lighting.

THE Fort Wayne alternate-current arc lighting system, in common with other such systems, consists of a combination of a constant current regulator and a number of arc lamps in series. The automatic regulator consists of an ш-shaped laminated iron core and a reactance coil surrounding its centre leg. The coil and core are hung on levers supported on knife-edges in such manner that the coil and core counterbalance each other and are both movable vertically. The levers are so arranged that of the total travel the coil moves over the greater portion of the distance. By this counterbalancing the equilibrium of the coil is maintained without extra weights, and the sensitive lever adjustment and small travel of parts produce practically dead-beat regulation of current.

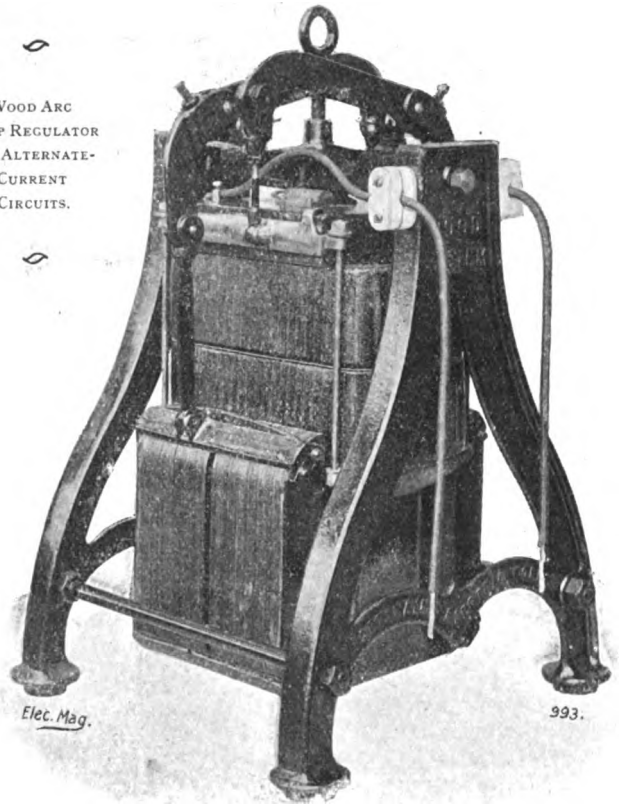
The regulator coil is connected in series with the arc lamp circuit, to which it furnishes a constant current suitable for the arc lamps on the line. The regulation is quite automatic. Any change in the resistance of the arc lamp circuit tends to produce a corresponding change in the current in the



TYPICAL AMERICAN SERIES ARC LAMP.

circuit, since the line voltage remains constant. But any change in the current changes the relative positions of the core and coil, an increasing current bringing them closer together, a decreasing current allowing them to move farther apart. As the core enters the coil when they approach each other, due to an increase in current, the additional reactance caused by the magnetic condition thus created serves to counteract the decreasing resistance of the line and introduces into the circuit such an impedance that the current remains constant. So perfect are the mechanical construction and electrical proportions of the regulator that the load may be reduced gradually from full load to no load until the regulator is

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WOOD ARC LAMP REGULATOR FOR ALTERNATE-CURRENT CIRCUITS.

directly across the line in short circuit without causing any marked change in the current. The load may also be changed from full load to short circuit with but momentary current variation. This ensures perfect protection to the system against short circuits due to failure of insulation of the outside lighting circuit.

When this type regulator is built for use on a small system of twenty-five lights or less, the lighting system may be connected directly to the machine circuit without the use of transformers. When, however, it is necessary to connect this series arc system to a machine supplying other circuits, a transformer is recommended. This transformer is connected between the machine and the series arc regulator circuit, ensuring perfect separation of the arc light circuit from any others supplied from the same machine.

The Fort Wayne system has been designed to take care of extensions and at the same time operate efficiently with the initial load. This is done by installing a regulator large enough to meet the maximum future demand on a transformer furnishing proper voltage to economically operate the regulator with this partial initial load. The lower voltage for this partial load is obtained from a series of transformer secondary taps by means of which the arc circuit voltage may be varied from 60 per cent. of full voltage up to maximum secondary voltage or full load in steps of such value that the circuit will always be working at approximately full-load efficiency. This method of transformation will allow a lighting plant to practically double its series arc lighting output without any increase in the regulating system or size of transformer, simply by changing the connections on the secondary taps of the transformer and at all times ensuring the highest economy and maximum power factor in the regulator circuit.

The illustrations show the "Wood" regulator mounted on a stand for station installation, and an arc lamp with leading-in wires. The knife-edges of the regulator are mounted on the casting supported on two A frames, between which the regulator is suspended. The joints in the levers furnish means for adjusting the regulator for the proper current.

Renewal of Incandescent Lamps.

MR. E. K. SCOTT gives in the *Electrical Review* some interesting particulars of the American practice of renewing lamps. The Edison Companies, which constitute seventy-four of the principal electric lighting concerns in the States, make a rule to give lamp renewals free. Their standard voltage varies from 108 to 124 volts, according to the taste and fancy of each individual company. Their 16-c.p. lamp takes fifty watts, and a large organisation, known as the Electrical Testing Laboratories, supervises the examination of the lamps, and ensures the use of high-efficiency ones only. Lamps generally burn for 500 hours before they are exchanged, and under no circumstances is the exchange of any lamp refused. The cost of lamp renewals works out at about ¼*d.* per unit of energy sold; but seeing that old lamps consume less energy besides giving much less light, the policy is not altogether so disinterested as one would suppose at first sight.

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For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

Wireless Telegraphy in 1904.

By L. H. WALTER, M.A., Assoc.M Inst.C.E., A.M.I.E.E.



THE year which has recently come to an end cannot be described as one lacking in interest from the point of view of wireless telegraphy, although there has again been an absence of any striking development or fundamental improvement such as would carry one with one bound to a point which by ordinary progress could only be reached after long-continued effort.

The chief feature may fairly be said to be the inauguration of legislative control for this new method of communication, and this has been sprung upon the world at large so suddenly and with such unanimity, in countries such as France, and probably also Germany and Russia, in which control has never been outside military and naval circles, that the year 1904 may be looked upon as marking the tacit recognition of wireless telegraphy as a factor to be reckoned with—important in peace and potent in war—at any rate in its possibilities if not in actual fact at present. The second feature, notable though of somewhat more localised interest, is the conclusion of the agreement between the British Post Office and the Marconi Company, by which the former agree to accept telegrams at any office for transmission to wireless telegraph stations, including ships at sea. This agreement only came into force on January 1, 1905, and consequently it is too early to be able to say how great a volume of business will result, but as marking a further acknowledgment of the claims of wireless telegraphy as an *adjunct* to wire telegraphy, the agreement is of great importance; it is also a legitimate development in a natural direction.

Both of these new chapters, so to say, in wireless telegraphy are directly traceable to one influence—the Russo-Japanese War in the East, in which not only has the utility of the method been shown somewhat more clearly than heretofore, but also the danger, in war-time, of the apparently innocuous, independent private station demonstrated in no uncertain manner to the Japanese, who rightly insisted on the dismantling of the Chifu station in the grounds of the Russian consulate there. The war led also to the remarkable enterprise of the *Times* newspaper in inaugurating, with American-like energy, a wireless telegraph war news column with the aid of Captain James, the steamer *Haimun*, and the de Forest outfit. It is to be regretted that the *Haimun's* career was so ingloriously and quickly brought to a close, but the Japanese, who did not lose sight of the possible danger, to themselves, of the newsy little steamer, were well within their rights—in fact, had the positions been reversed, and the Russians been attacking Port Arthur, it is probable that a worse fate would have befallen her.

As regards the real utility of wireless telegraphy in war it is difficult to obtain accurate information, but the interference

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evil seems to be still one of the greatest drawbacks to its general use in this direction. It is rather to be wondered at that a nation so scientifically up-to-date as the Japanese are, has not secured some outfits of one of the so-called interference-free systems; but perhaps these only exist on paper.

Coming now to the more technical part it is difficult to point out any single special development. There are tendencies of course. Last year the tendency was noticed to be towards the undamped wave train, and Professor Artom's was the only system which aimed at directed emission and reception of the waves. This year a number of other workers have been expending their energies in a similar direction, Dr. de Forest having evolved a directed system in which concentrating reflectors are made use of for directive purposes, a part of the antenna being laid horizontal and in the direction in which the communication is to be effected, and one or two others have patented systems concerning which not sufficient information is as yet available for an opinion to be formed as to their merits. In the way of syntonic or selective systems little progress in the direction of non-interference appears to have been made if a method of Professor Fessenden's, which seems to promise well, be excepted. In this, the emission of waves is continuous, and it is the frequency and not the intensity which is altered, such alteration in frequency of giving rise to the signals. It is stated that several United States cruisers are to be specially equipped with this system so as to be free from the liability to interference; and while this may be so in ordinary cases there is no such freedom to be looked for when, or if, other or hostile vessels are fitted with similar apparatus. There are a number of other systems, selective and otherwise, which have been brought out during the past twelve months, and among these may be mentioned the mechanical resonance method of Professor Pupin, the peaked-wave method of Troy, and the selective method of Hogg, the latter using two coherers in series, placed in separate tuned circuits.

It is in the elaboration of the separate units which go to constitute a system that the greatest advance has again been made. Dealing first with the transmitter, the new method of Professor Braun's, of increasing the transmitter energy (by the combination of a subdivision of the spark-gap and the charging up of condensers in parallel, and letting them discharge in series) deserves special mention; this is not a discovery, but the result of carefully applied theoretical knowledge. Another method of accomplishing the same object has just been described by Dr. Seibt, and consists in tuning the receiver to both the waves, of different frequency, present in the transmitter in place of to a single one only as has hitherto been customary; but in this method the power can only be doubled. Professor Slaby in his papers on the "Tuning of Wireless Telegraph Transmitters," has also indicated a method of indirectly producing the same result by diminishing the damping of the spark-gap. Signor Marconi and Professor Stone have made some improvements in antennæ, the former in substituting for a portion of the vertical height a horizontal portion; the latter has described several forms of aerial appendages which tend to reduce the height necessary, and consequent expense and liability to damage.

The spark-gap itself has come in for a greater share of attention at the hands of physicists during the year, it being recognised that besides being one of the most important parts it is one of the least thoroughly understood. The recent work of Professor Drude and of Simons, on the resistance and damping of the spark-gap in air, have added materially to the knowledge of the subject, and that of Pierce, on the mercury-vapour interrupter, has also demonstrated the probable advantage to be obtained by the use of this in place of the gap in air. Of minor importance are the ionising of the spark-gap, proposed by de Forest, and the provision of fresh surfaces at the gap, by making the electrodes in the form of discs which are continuously rotated, an arrangement of Professor Fleming's. The first is another method by which the breaking of the high-powered primary circuit can be dispensed with, while the second ensures greater regularity in the succession of the wave trains.

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The receiver has not benefited to the same extent as the transmitter, although of new receiving instruments there are quite a number; but by far the greater part of these are wave detectors pure and simple which are quite incapable of being used for practical wireless telegraphic purposes, though as physical-measuring instruments they may render effective service. Taking those first which are capable of rapid work, the receiver which has drawn the greatest attention to it is the de Forest electrolytic cell detector. This is simply a variant of the Schloemilch polarisation cell detector which appeared at the end of 1903, and so is not strictly novel. Very good results seem to be obtained with this form of receiver which is known in various forms as the Schloemilch, the Fessenden, and the de Forest respectively; its sensitiveness is undoubted, but owing to the fact that it is a potential-operated device, as stated by de Forest, and also that it responds when one electrode only is connected, as stated by Ives, it must share to some extent the drawbacks of its predecessor the coherer, from the disadvantages of which the current-actuated type is exempt. Of new receivers of the magnetic type there are several. The telegraphonic receiver of Reich is an interesting application of the Poulsen method to Rutherford's detector, but little is known as to its practical capabilities. The metrical detector of Walter and Ewing and its two somewhat belated imitations, the Arnò and the Peukert detectors, show the tendency towards the provision of instruments which give quantitative and visible results without the intermediary of telephones or recording instruments. Dr. de Forest has also patented a magnetic detector. This is of the Marconi fixed core type, the only alteration being the provision of a demagnetising coil inside the magnetic shell as well as outside. Another form of Marconi detector has been patented by Troy, and in this the core is made of magnetic filings through which the oscillations are caused to pass, the filings being normally subjected to a varying alternating field. A further receiver by Troy is based upon Edison's electromotograph. Of coherers there are numerous new ones calling for no special mention, but the Maskelyne coherer, which is of the latest Branly type, is a workmanlike piece of apparatus and seems to have given good results—as far as coherers go.

Another device tending towards the improvement of wireless telegraphic service in general is that of Marconi in which, from a potential node on the aerial several earth connections of different capacity and inductance are led off, having, it is said, the effect of not merely shunting the disturbing currents, but even improving the signals. The Gesellschaft für Drahtlose Telegraphie have also introduced a number of refinements—they cannot be called inventions—into their apparatus. One of these consists of a method of reducing the receiver sensitiveness without altering the electrical constants of the circuit.

The instrumental section has received some notable additions. Of detectors there are the Karpen electro-dynamometer and the Duddell thermo-galvanometer. The latter furnishes a useful direct-reading substitute for the bolometer. Of measuring instruments other than receivers there is the wave-length meter of de Forest and Ives, with which the measurements were obtained for the interesting paper published by the latter on "Resonance in Aerial Systems." Another instrument for a similar purpose is the spiral helix of Fleming, which was shown at the British Association Meeting at Cambridge. This is a form of Seibt apparatus, the observations being, however, made by means of a neon tube in place of the brush discharge, so that readings can be taken in daylight.

Among subsidiary devices designed for special applications may be mentioned the range-finder of de Forest, in which a variable resistance is put in series with the responder, and more and more resistance put in until the signals cease to be audible. The resistance arm is provided with an index and a scale graduated by experiment. The chief difficulty is that a standard transmitter is required, thus depriving the range-finder of its chief value—the estimation of the distance of hostile ships. Another instrument, a position finder is the telemobiloscope of Hülsmeyer. In this, use is made of the property of metallic objects, of reflecting the electric waves. Waves emitted by

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a ship are reflected, say, by an enemy's ship; the waves will be reflected back from the hull to the transmitter. The interesting part of this invention consists in what is *not* known, viz., how the receiver is protected from the transmitter on the same spot when receiving is being simultaneously carried out. Other interesting applications are the wireless fire-alarm of Guarini, the transmission of time signals at sea, and the system of danger signals for coast and harbour use, devised by de Forest. It is impossible to consider any record of the year's work and advance in any way as complete without reference to the valuable papers which more and more frequently are now published by physicists who are thus practically co-operating in the development of the subject although some of the more practical (?) workers have tried to belittle their efforts. The papers of Abraham, Chant, Drude, de Forest, Giminez, Ives, Rothmund and Lessing, Slaby, and Stone should be noted in this connection.

In conclusion, it may be said at the commencement of this new era for wireless telegraphy—it has come to stay. There have been several reasons for the comparative slowness of its *practical* development, but some of these have disappeared and others may follow. It is well to bear in mind that there is still room for a simple *really* selective system without mechanical complications and not depending on such an elastic thing as tuning. There is little doubt that the air would be cleared somewhat by a little storm in the shape of patent litigation. This should be the next tendency—unless a new one rapidly develops.

Telegraphs in 1904.

By E. O. WALKER, C.I.E., M.I.E.E.

WHILE the actual expansions of telegraph systems last year have not been equal to the normal, the dull state of trade has not prevented a very sensible increase in the means of communication. Notwithstanding the threatened rivalry of wireless telegraphy in the sphere of ocean lines, which at one time somewhat tended to arrest commercial interest in cables, and to cause some government administrations to hesitate in extending them, the better appreciation of the real possibilities of wireless telegraphy, and of its limitations has set in, and has restored confidence. So that we have seen telegraph cable stocks rehabilitated, and cable extensions revived. An American made cable has been laid from Seattle to Valdez in Alaska. A fresh length of cable, forty-seven miles in length, made at Hooper's Telegraph Works, has been laid for the Cuba Submarine Company, the final section of the second German Atlantic cable has been disposed of, and new cables have been projected from Brest to Dakar for the French Government (which will be made by the Société Industrielle des Téléphones), and from Constanza to Constantinople by the East European Telegraph Company of Berlin. Further, agreements have been entered into between Holland and France for a cable between Saigon and Pontianak, and between Germany and Holland for one between Java, Celebes, and Menádo, the German-Dutch Company being empowered to continue the communication thence to the Philippine Islands, Guam, and Shanghai. In connection with existing systems it is understood that the Indo-European Telegraph Company has acquired the cable between Odessa and Constantinople by purchase. The same Company has extended its extraordinarily long circuit to Manchester, which enables that place to work to Teheran by automatic relay translation (see p. 191). Finally, in the cable world, interest has been displayed in the projected connection between Iceland and the Faroe Islands, and thence *via* the Shetlands to Britain, but, at the moment, there is want of positive assurance that the cable will be laid in 1905.

The International Telegraph Congress has introduced revised regulations for international telegrams which have given a fresh stimulus to codification, and this will in the end prove, it is anticipated, productive of cheaper means of telegraphing in the commercial world, as well as greater accuracy in the signals transmitted.

As regards the technical aspect of cable work no marked improvements in apparatus have been exhibited during the year 1904, but the utmost possible

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performance has, in many cases, been secured with the existing types. The competition between the Pacific and the Eastern Extension cables has been productive of higher speeds, which some years ago would not have been contemplated, but the traffics are not sufficiently large to make such speeds generally applicable to the whole of the twenty-four hours. A large traffic would be welcomed and would enable the Pacific Cable to pay its way after making provision for depreciation and sinking-fund. In the absence of a sufficiently large volume it would not be surprising if, some day, the Pacific Cable were administered jointly with the Eastern Extension Cables. Before quitting the subject of submarine cable telegraphy it would not be right to omit mention of the Armstrong and Orling recorder, of the electro-capillary type, by which, it is said, a speed of eighty words per minute has been attained through an Atlantic cable. This is a remarkable result, but the photographic record may prove a disadvantage. It is not improbable that the wide feeling in favour of State-owned cables throughout the Empire, expressed recently by the Associated Chambers of Commerce may, in a few years, take practical shape, in which case large systems would be brought under State control on terms possibly arranged by arbitration.

Two new cable steamers have been launched during 1904, namely, the *Cambria*, for the Telegraph Construction and Maintenance Company and the *Stephan*, a German boat, built at the Vulcan Works, Stettin.

Endeavours have and are being made in Germany to turn out cables insulated on a cheaper plan than those which employ rubber and gutta-percha. So far, in respect of the short lengths used for telephone purposes in the sea waters adjacent to Denmark and Germany, the new modes of insulation have proved satisfactory, and they will probably be extended in use.

Sound signalling under water for communication between ships, or ships and beacons, promises to be electrically developed. The Submarine Signal Company of the United States has successfully bridged a distance of seven miles with a bell sounder at one place, and a microphonic receiver fixed to the hull of a ship at the other, the sea being stormy at the time and therefore adverse to good signals.

In the region of high-speed telegraphs a system essentially based upon that of Bain, has been introduced by Delany in the United States, in which the inventor utilises the retarding influence of capacity of the line to record intervals. Delany claims that he can obtain a speed of 1,000 words per minute through 300 miles of overhead line. There has been no recent account of commercial telegrams having, however, been regularly dealt with by this system, although from the nature of the device there is no reason to doubt its success as a high-speed apparatus. The Pollak-Virag recording telegraph which now employs an automatic sender with perforated tape, and a photographic record at the receiving-station has recently been exhibited in London, and is likely to be experimented upon in the British Post Office. Such systems, similarly to some other high-speed systems, require the manual operations of the telegraphist in preparation of the tape, and in the translation of the record at the receiving station; the average speed of telegrams being thus considerably reduced by these operations. These facts have to be considered when assessing the commercial value of the systems under notice. In Germany the possibility of the adoption by the Government of the Siemens and Halske's spark recorder is entertained, Rowland's apparatus having migrated to Italy. Still, the Murray printing telegraph is answering well between Berlin and Emden, and as the received slip can be machine printed for delivery to the addressee, it may be that its success may delay the decision in favour of Siemens' apparatus, with its photographic record. It should be mentioned that the Pollak-Virag system requires two line wires, which the other systems mentioned do not; so that here it is at a disadvantage. The high speed perhaps may overcome this disparity in the effectual per mile of wire rendering, as 700 words per minute have been sent by the Pollak-Virag telegraph over a loop 440 miles in length. The sensitised paper used with it has been improved, development occupying only five or six

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seconds and fixing about as many. The advance made in the year under review in the direction of high-speed working has been very encouraging.

As regards multiphase systems, important alterations in the keyboards of the Baudot telegraph (proposed by Dubreuil) and in the Hughes apparatus (suggested by Conradt), seem to promise an increased output per operator per hour. In the Hughes, Conradt also proposes to alter the gearing of the type-wheel to further enhance the speed of transmission. Again in France Estaunié has found by experiment that the driving mechanism of the Hughes can be made more regular, and the speed improved by the use of an electro-magnetic in place of a mechanical clutch. In the United States in the past year Field has brought out a multiplex system based on the use of tuned reeds.

It is difficult to say at present whether the high-speed simplex working telegraph will ultimately take the place now occupied by multiplex systems. It will require time to decide ultimately which has the greatest commercial value when used upon existing circuits, and upon those which are being laid underground.

In England there is now a considerable length of subterranean line. It is complete from London to Manchester, and from Stafford to Warrington, and is being proceeded with further to the north, the pipes being laid to Carlisle.

The use of telephone trunk lines for simultaneous telegraphy and telephony is extending in America and in Germany, and being so eminently economical must eventually recommend itself to all countries. With proper arrangements the telegraph can be worked over the metallic telephone circuit, using earth for the former, with practically no detriment to the telephones. Therefore, both inside and outside our towns there should to-day be no necessity for installing new telegraph wires, except where no telephones exist. One important international circuit at least is employed for the dual purpose, and this being so there is little doubt but that all such circuits will in time be made available for similar service.

For railway signal systems the use of electric and of electro-pneumatic devices has been much extended during the past year. The Hall system is on trial on the North Eastern Railway between Alne and Thirsk. The new Bolton station of the Lancashire and Yorkshire Railway has been entirely fitted at the various points and signals with the electro-pneumatic system of the Westinghouse Brake Company, the power being also utilised for 800 electric lights and twenty-one cranes. At Derby a section of the Midland Railway has been fitted with purely electrically operated signals for the purpose of testing their efficiency as against mechanical interlocking. The New York Electric Railway has been fitted with electro-pneumatic signals and switches in the Subway division. The Highbury station of the Great Northern and City Railway has six signals operated with Westinghouse automatic arrangements. At Crewe the electric system has justified the outlay upon its installation in the labour saved in operating points and signals. The new Paragon Station at Hull is being fitted with Westinghouse signals. Many endeavours have been made in the past to provide the engine-driver with a signal in his cab which will enable him to know the state of the road in front when fog prevails, and also to obviate the use of the ordinary fog signals laid on the track. For such a purpose Van Hoet of Haarlem has brought out recently a device which is planted in the middle of the track, and is mechanically connected with the semaphore. Contact is made with a lamp circuit on the engine by springs fixed below the latter. The cross-arms of the device are at right angles to, or longitudinal with the rails, according to the position of the semaphore, and a red or a white lamp according to circumstances is illumined as the locomotive passes over the cross-arms. Among many other laudable attempts to produce a workable automatic signal the present one appears to be promising.

The employment of street fire-alarm communication is considerably on the increase. In London there are now 927 public call-points and 264 telephone lines for police stations. The use of automatic alarms in buildings is growing and will, no doubt in time, lead to a reduction in rates for insurance against

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fire. It has been suggested to utilise wireless telegraphy more generally for the purpose of alarms.

The year has generally been a dull one as regards demand for telegraph apparatus, material, and cables. The export from the United Kingdom of the latter was less than half of the value shipped in 1903. But a slightly increased demand has lately arisen, and, both at home and abroad, there is promise of an improved state of affairs when financial facilities become re-established.

Telephonic Progress in Great Britain.

ALTHOUGH we are not quite so advanced in the use of the telephone as our American cousins, who claim to lead the world, the telephone business in Great Britain has made great strides during the past year, especially in municipal telephony.

The most important work carried out by the National Telephone Company during the past year has been the opening of their new exchange on the central battery and lamp system at Holborn, London, the switchboard being designed for 8,750 direct lines. The change in the system was apparently not appreciated by the operators who came out on strike. Happily for those who depend on the telephone, the Company conceded the demands of the dissatisfied operators, and peace reigned in a few days. The Corporations of Glasgow, Brighton, Portsmouth, Swansea, and Hull have made highly satisfactory progress during the past twelve months. At Glasgow 1,504 new subscribers were added during the year, making a total of 12,970, Brighton 1,199 increase, total 1,652; Portsmouth, 553 increase, total 2,059; Swansea, 488 increase, total 1,078, and Hull, which only officially inaugurated their system in November, had 1,002 subscribers at the end of the year. The account of the above Corporations for the past twelve months are not yet to hand, but we have every reason to believe that the results are most gratifying to all concerned. We are told Brighton is making a profit of about £100 per month, and Portsmouth is doing much better than this.

"Sunny" Guernsey, the pioneer of local governed telephones, is still the best telephoned place in the United Kingdom, having added 158 new lines during the year, making a total of 1,405 connected at December 31, 1904, whilst the profit after paying the usual Post Office royalty of 10 per cent. on the gross receipts, setting aside 5 per cent. for sinking-fund and depreciation, and paying interest on capital, managed to make a profit of close on £300, and this in spite of the low charge of 30s. rental per annum, and one penny per outward call. The proportion of telephones in Guernsey is one to every twenty-eight inhabitants.

We now know that systems owned and worked by Corporations charge half the rates formerly charged by the National Telephone Company, and yet satisfactory profits are being made, which in several places are being applied to lighten the burden of the ratepayer instead of increasing it as was prophesied by the opponents of municipal telephony. The lowering of rates has not only benefited telephone subscribers by extending the telephone system in many parts of the country but has provided remunerative employment for hundreds of employees of both sexes, and given the so long looked-for stimulus to the cable industry and telephone appliance works.

The Post Office exchange in Carter Lane, London, is fitted throughout on the lamp and central battery system, with special subsidiary sections arranged for subscribers renting special trunk, and foreign lines to France and Belgium. A special section is also fitted for the training of operators, and in this respect the Post Office are doing all that is possible to obtain operators of the highest standard.

The number of subscribers in the Metropolitan area is now close on 23,000. The Post Office and all modern Exchanges have been fitted on the latest fireproofing principles. The serious loss and inconvenience caused through interruption to telephonic communication through fire or any other cause is difficult to estimate, and no precautions can be considered too great which tend to minimise interruptions. Actual damage to 3,000 telephone underground cable wires in New York, last year amounted to £2,500. The fire was caused through temporary

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coverings wrapped round cables during railway subways construction being accidentally set on fire by a workman using a gasoline torch.

Automatic telephone systems have not made any headway in this country during the past twelve months, but the systems of Strowger, Fuller, and Lorimer, have been introduced in many places in America. British engineers have fought shy of automatic systems, being quite content to wait till the "scrap-heaping" process has produced something reliable before venturing to displace the "number please" young ladies. Still, there must be something in automatic systems when we find that the number of lines worked in America by such system totals about 33,000. The adherents of automatic systems claim that a great saving in prime cost of operating expenses is effected by the use of automatic switchboards, but we are afraid it is yet too early actually to prove this. Possibly when the mechanism has been simplified, and the number of contacts depending on same have been reduced, the service will be much improved, and the cost of construction and maintenance lessened. Until then, manual systems, with all their faults, will hold the field.

Lately, the daily papers have contained rumours that the Post Office and the National Telephone Company had completed the agreement for purchase of the latter company's system, and that the company had made a good bargain. If this eventually proves to be true we can only say that the lesson learned by the Post Office, when they purchased at full cost the trunk lines of the National Company some twelve years ago, has been forgotten, and the mistake made then is likely to be eclipsed. The danger in Government control of the telephone is that the Post Office will not alter its methods of department administration to meet the requirements of such a gigantic and swift concern as the telephone system.

Unless this is done the rapid progress of telephony in the country is doomed. As we have before pointed out the Government ought to encourage Corporations to acquire and work telephone systems of their own. With encouragement from the Post Office, and the extinction of the 10 per cent. royalty, the question would be simplified, and little or no further Government interference would be required.

Great interest has been taken in wireless telephony, and the system worked out by Mr. G. F. Collins of America gives promise of great things. The tests made between ferry-boats on the Hudson River proved that articulate speech is possible over a clear distance of more than a mile. In the harbour where the conditions were somewhat different the distance covered was only about 1,000 ft. The system is in the nature of a combination of the ordinary telephone receiver and transmitter, and wireless telegraph apparatus in which the Hertzian wave phenomena is employed. The period of alternation at which the telephone receiver operated the best was between one and two thousand. In the experiments a closed circuit oscillator and resonator was employed, so that oscillations would be rendered as persistent as possible. This system of wireless telephony properly cultured should be of service for short distances, and it was successfully tried on ferry-boats going in opposite directions on the Hudson River.

Another system is that of Professor Simon and Mr. Ernest Ruhmer of Germany. In this system parabolic type mirrors are employed in conjunction with an arc lamp, carbon telephone transmitter and ordinary telephone receiver with Ruhmer selenium cells and storage battery giving a tension of 40 to 80 volts.

The speaking arc light used in the projector is operated at from two to four amperes in clear weather, and up to ten amperes in unfavourable weather at a pressure as high as 220 volts. The apparatus as made by the Siemens-Schuckert Werke in Berlin is very light and portable, and the ease with which it can be moved about ought to make it of value for temporary stations which do not permit of a telephone line being installed.

We have made arrangements for a number of valuable articles on Telephone and Telegraph matters to appear in this section during the present year. On no account fail to read them.

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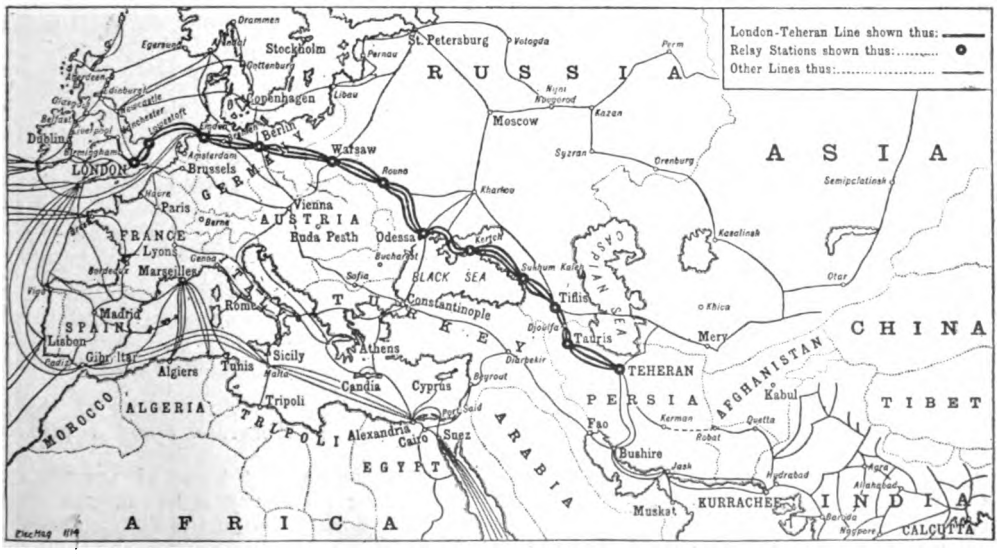
ENGLAND AND TEHERAN DIRECT CONNECTED BY TELEGRAPH.

THE political importance to Great Britain of direct telegraphic communication between London and India must appeal to all observers of Imperial affairs, and it is a matter for congratulation that the Indo-European Telegraph Company has now directly coupled the Metropolis with Teheran. This improvement will, doubtless, be followed by others, making the link even more complete and what is now a receiving station—Teheran—a relay station similar to others on the line. In a recent issue, *The Electrician* published a description with technical details and diagrams of this highly important work, from the pen of T. W. Stratford-Andrews. We shall give fuller particulars next month of the apparatus used, giving in this issue the map of the route and some account of the stations and circuits, taken from our esteemed contemporary. Hitherto there have been two retransmissions on the line at Emden, Germany, and Odessa, South Russia, while Manchester and Liverpool messages have also been retransmitted in London.

The establishment of this direct service is a record achievement, and reflects creditably on the enterprise of the company in question. To bridge 4,000 miles of space with 200 miles of deep-sea cables, and wires overhead subjected for the most part to the perils of storm and tempest, cold and heat, is a feat ranking high among the many and varied labours of telegraph engineers. In addition, the more exposed portions of the line in Russia and Persia need an amount of supervision unapproachable by anything similar in telegraph operation.

Morse working, hitherto general throughout the company's system, gave place to the Wheatstone between Odessa and Teheran in 1897 with such success that experiments to convert the "home" section were at once undertaken, culminating in complete success. The entire length was operated by Wheatstone on January 1, 1903. The English and German postal authorities had first to be convinced that no induction disturbances would be set up in the Norderney and Borkum cables, one each of which was used by the company. The relay stations are clearly marked on the accompanying map, there being ten in all, the relays in each case being automatic.

At the London station the translation to Liverpool and Manchester, as well as the ordinary work, is in the hands of one operating clerk. The method devised by one of the company's staff is extremely simple, as indeed it must be for controlling by one operator. Four relays are used and the entire apparatus could be fixed on a board 18 in. square, so compact is its design. The arrangement admits of London working direct from Teheran, and with Liverpool and Manchester independently, or of Teheran being put directly in connection with Liverpool and Manchester or *vice versa*.


London-Teheran Line shown thus:
Relay Stations shown thus:
Other Lines thus:
RUSSIA
ASIA
EUROPE
AUSTRIA
FRANCE
SPAIN
TURKEY
PERSIA
ARABIA
AFRICA
INDIA
CHINA
TIBET
AFGHANISTAN
LONDON
Berlin
Warsaw
Moscow
Vienna
Paris
Constantinople
TEHERAN
Tiflis
Tabriz
Bushire
KURRACHEE
CALCUTTA
Odessa
Athens
Cairo
Suez
Alexandria
Tripoli
Algiers
Tunis
Sicily
Candia
Cyprus
Muskat
Kabul
Mery
Khiva
Orenburg
Semipolatinsk
Kazalinsk
Otar
Quetta
Hydrabad
Bombay
Madras
Lisbon
Gibraltar
Marseilles
Lyons
Brussels
Amsterdam
Copenhagen
Stockholm
St. Petersburg
Erzerum
Baku
Tauris
Djoulfa
Bagdad
Basra
Fao
Kerman
Jask
Robat
Aden
Malta
Bizerta
Tripoli
Alexandria
Port Said
Beyrout
Smyrna
Constantinople
Sofia
Bucharest
Buda Pesth
Prague
Berne
Genoa
Rome
Naples
Malta
Sicily
Tunis
Algiers
Gibraltar
Lisbon
Madrid
Cadiz
Dublin
Belfast
Liverpool
Manchester
Leeds
Sheffield
Birmingham
Glasgow
Edinburgh
Newcastle
Hull
Yarmouth
Ostend
Calais
Boulogne
Havre
Cherbourg
Dieppe
Flushing
Antwerp
Ostend
Hamburg
Emden
Libau
Riga
Wirballen
Eydtkuhnen
Thorn
Posen
Breslau
Dresden
Leipzig
Cologne
Frankfort
Munich
Stuttgart
Strasburg
Basle
Zurich
Milan
Venice
Trieste
Fiume
Agram
Lemberg
Kieff
Kharkow
Kursk
Tula
Moscow
Nijni Novgorod
Perm
Vologda
Wiatka
Kazan
Syzran
Saratoff
Samara
Ufa
Orsk
Tashkend
Khokand
Andijan
Kashgar
Yarkand
Khotan
Aksu
Kuldja
Urumtsi
Hami
Barkul
Turfan
Karashar
Kucha
Ili
Semipalatinsk
Omsk
Tomsk
Irkutsk
Yakutsk
Vladivostock
Nikolaievsk
Petropavlovsk
Okhotsk
Blagovestchensk
Khabarovsk
Nikolsk
Port Arthur
Chefoo
Shanghai
Hankow
Ichang
Chungking
Yunnanfu
Mandalay
Rangoon
Bangkok
Singapore
Penang
Calcutta
Madras
Bombay
Karachee
Hydrabad
Quetta
Kabul
Herat
Meshed
Bushire
Fao
Bagdad
Mosul
Aleppo
Damascus
Jerusalem
Gaza
Suez
Cairo

Telegraphy Correspondence Class.

Conducted by CICERONE.

WITH this issue of the Magazine, the first set of six double-barrelled questions in connection with the Correspondence Class in telegraphy and telephony is published. All readers who are interested in these subjects are invited to attempt answering all the questions, or as many as they feel capable of undertaking. The scheme is a novel one, experimental and tentative, and, as was intimated in the introductory article announcing its details in our December issue, it is capable of considerable development. Intending students should, therefore, commence at once to take part in the enterprise, and assist in making it a success. An intelligent, active, and competitive interest in such a system of self-help and mutual aid is bound to have beneficial effect from an educative point of view, and will result, it is hoped, in instilling a healthy rivalry amongst the competitors, and in fostering a love for the science amongst those who have already devoted some of their time to its study.

It is premature at present to speculate upon the possibilities of the project, but it may safely be predicted, whether success or failure attend it, that all those who enter the list of competitors will profit thereby, some perhaps in a manner not, in the meantime, expected. Until it is ascertained how far the idea is to prove acceptable to our readers, no prizes can be offered excepting one. To the competitor who submits the greatest number of correct solutions during the year, will be presented free copies of the Magazine along with their binding cases for the ensuing year. It may be that the date, already fixed for submitting answers, will have to be somewhat extended to accommodate foreign and colonial subscribers, but that is one of several points that will have to be determined as experience dictates.

Answers, which should be written on one side of the paper only, must reach the offices of the Magazine addressed to Cicerone not later than the fifth of next month. A fresh sheet of paper should be used for every question, and the writer's *nom de plume* written on the top of every sheet.

In the succeeding issue of the Magazine, all necessary corrections will be pointed out, to each competitor, under his or her *nom de plume*, and a few specimens of the most accurate and lucid answers will also be given, together with another set of six problems.

The next set of questions will be derived from Ohm's Law (particularly in its reference to the grouping of cells into batteries) and from the electro-chemical laws relating to the consumption or transformation of the constituents of a cell.

As soon as students have finished their answers to the questions given below, they should at once begin to master the principles of Ohm's Law, with deductions therefrom, in preparation for the next set of questions. Any standard text-book on electricity and magnetism will serve for this purpose, as all of them devote considerable space to the enunciation of the important law which expresses the relationship between electromotive-force, resistance, and current.

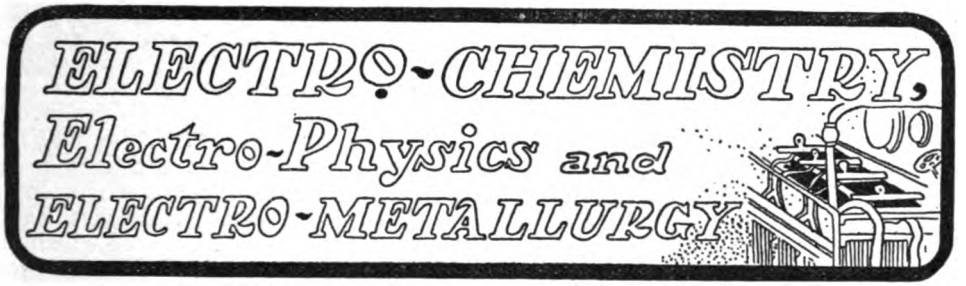
For assistance in solving the present series of questions any of the following works may be profitably consulted. Professor Ayrton's *Practical Electricity*, Dr. S P. Thompson's *Elementary Lessons in Electricity and Magnetism*, Dr. Walmsley's *Electric Current*, Joubert's (translated) *Electricity and Magnetism*, or Preece and Sievewright's text-book on *Telegraphy*.

For historical research, regarding the disputed contact and chemical theories, of the source of electromotive force in a cell, students may be referred to the excellent text-book of Fleeming Jenkin, redolent of the old fight, while Professor Noad's lectures, now embodied in a comprehensive work, the later editions of which have been edited by Sir William Preece, are none the less interesting.

EXERCISE I.—FEBRUARY 1905.

1. (*a*) Describe the action of the Daniell cell.
   (*b*) Upon what does its constancy depend ?
2. (*a*) In what respect does chemical osmotic action differ from electrical endosmose ?
   (*b*) What is meant by local action, and how can it be prevented ?
3. (*a*) Define galvanic polarisation.
   (*b*) Describe some methods of eliminating its effects.
4. (*a*) Discuss the merits and demerits of the Daniell, Leclanché, and Bichromate cells for telegraphic and telephonic purposes.
   (*b*) Upon what properties do electromotive force (E) potential difference(p.d.) resistance (R) and current (C) depend ?
5. (*a*) How would you construct a standard cell ?
   (*b*) State generally the effect of change of temperature upon a primary cell.
6. (*a*) Describe any form of accumulator or secondary cell, and its action during charge and discharge.
   (*b*) What are its advantages and disadvantages over the primary cell in a telegraph office or telephone exchange ?

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Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

Electro-Metallurgy in 1904.

By JOHN B. C. KERSHAW, F.I.C.

The United Kingdom.

INDUSTRIAL electro-metallurgy in this country is represented by the *Aluminium, Calcium Carbide, Copper, Tin, and Zinc* Industries. The first-named metal is manufactured at Foyers, North Britain, by the British Aluminium Company, and during the past year additions have been made to the producing plant. This is now capable of utilising over 4,000 h.p., and of turning out 1,150 tons of the metal per year. It is hoped to have the whole of the enlarged plant engaged in Aluminium production by the end of the present year, as the demand for the metal in the United Kingdom is increasing. The finances of the company have also been re-organised during 1904, and fresh capital has been raised to develop a new water-power centre on Loch Leven.

Calcium Carbide is produced only at two small water-power centres—at Ingleton in North Lancashire, and at Askeaton, co. Limerick in Ireland. The production at Foyers under a licence from the Acetylene Illuminating Company, has been stopped, owing to the requirements of all the power for the Aluminium manufacture, and to other causes. The United Alkali Company of Liverpool, have also ceased to manufacture this product—by steam-power—and nearly the whole of the calcium carbide sold in this country, is now imported from abroad—chiefly from Sweden and Norway. The long-contested Patents Infringement case between the Acetylene Illuminating Company and the United Alkali Company, which hinged upon the validity of the Willson patents for carbide productions in this country, has been finally decided by a House of Lords decision in favour of the defendants—the United Alkali Company. The manufacture of calcium carbide can therefore now be taken up by any firm, but owing to the keen competition from cheap water-power centres abroad, the industry is unlikely to extend in this country.

The Copper Refining industry is represented by six refineries, turning out (according to Ulke) 8.8 per cent. of the total world production of electrolytic copper. These refineries are situated at Pembrey, Swansea, Froghall, Widnes (2) and Hunslet—the last named being one operating the Elmore process for manufacture of copper tubes by deposition upon a revolving mandril. The refining industry is not in a very flourishing condition. It is difficult for English refiners to obtain the necessary supplies of raw copper suited for the electrolytic refining process—since the great extension of the industry in U.S.A.

Tin.—The electrolytic process for stripping the tin from scrap and old tins from the city garbage heaps, is believed to be in operation at Birmingham, at Swansea, and at one or two other places in the United Kingdom; but it is difficult to obtain any reliable information concerning the exact status and development of this branch industry. The process employed is based upon use of the scrap-tin as anode, in an electrolytic of sodium stannate, or tin-chloride; and recovery of the metal by deposition at the cathode, in metallic form.

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Zinc.—Zinc is produced by the Hoepfner process at Messrs. Brunner Mond and Company's Winnington Works, in Cheshire. This process is based upon the formation of a zinc chloride solution from the waste calcium chloride liquors of the ammonia soda process; and upon recovery of both the zinc and the chloride by electrolysis. Over 1,200 h.p. is reported to be in use at this plant, and the output is stated to be three tons of zinc and nine tons of bleach per day. The Swinburne-Ashcroft process for extracting all the metals from mixed sulphide ores of lead and zinc is operated at Weston Point, by the Castner Kellner Company, but only zinc chloride is produced, this product being sold instead of separated by electrolytic treatment into its two constituents zinc and chlorine. The plant at present has a capacity of thirty tons of ore per week.

France.—*Aluminium* is produced in France by the Heroult process at La Praz, and by the Hall process at St. Michel. Each of these works produces other products, and no very reliable information is available as to the present output at these two places. According to one authority the industry is practically stationary, the annual consumption in France being nine hundred tons, while the production is about 1,200 tons.

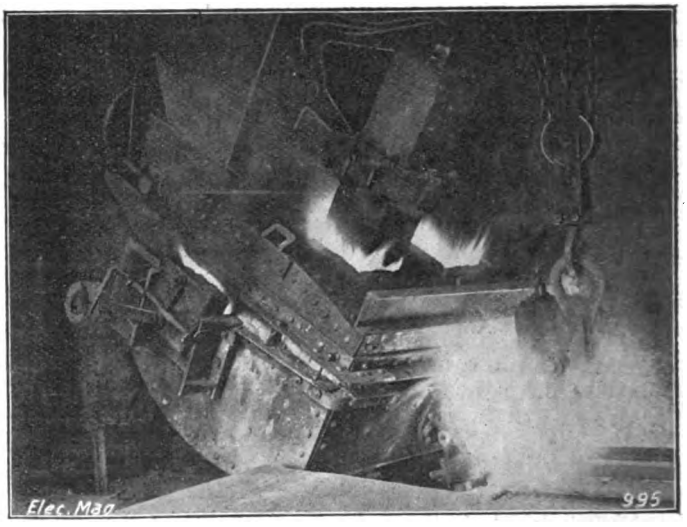


FIG. 1.—THE HEROULT STEEL FURNACE DISCHARGING AT LA PRAZ, FRANCE.

Calcium Carbide.—This manufacture is still carried on in France at a large number of water-power centres, but quite one-half of the twenty-six works planned and erected for this manufacture in the years of "boom," 1898–1900, have been obliged to find some other outlet for their power, as a result of over-production and consequent fall in the price of carbide. The production and price are now regulated by a central Sales Bureau with headquarters in Paris, and the manufacture is concentrated in a few of the best-situated and best-managed works, having cheaply developed water-power available for the furnaces.

A new plant has been started at Les Clavaux during 1904. The consumption of carbide in France was stated to be 13,000 tons in 1902, and is rapidly increasing; while the production is now 25,000 tons, on the authority of M. Hulin.

The Copper Refining industry in France is of minor importance, and little authentic information is to be had concerning the refineries at Marseilles, Biache, Eguille, and Pont-de-Chéruy, none of which is of any size. According to Ulke, the French refineries contribute only 1.6 per cent. to the total output of electrolytic copper; and the development of the industry is hindered by the causes that hinder it, in the United Kingdom. An Elmore copper works is in operation at Dives, and this is reported to be more successful than the English works at Hunslet.

Ferro-Chrome, Ferro-Silicon, and similar Alloys.—The manufacture of alloys of iron and the rarer metals, for use in the preparation of special brands of iron and steel, has developed into an important industry in France, a result due to the slump in the carbide industry in 1900, and to the large amount of electric power and furnace plant left without profitable use at the close of that year. Works for production of these alloys are in operation at Bozel, Livet, La Praz, Froges, St. Michel, Lavel, and Ugines. As in the case of carbide, over-production has occurred, and some of these works have been com-

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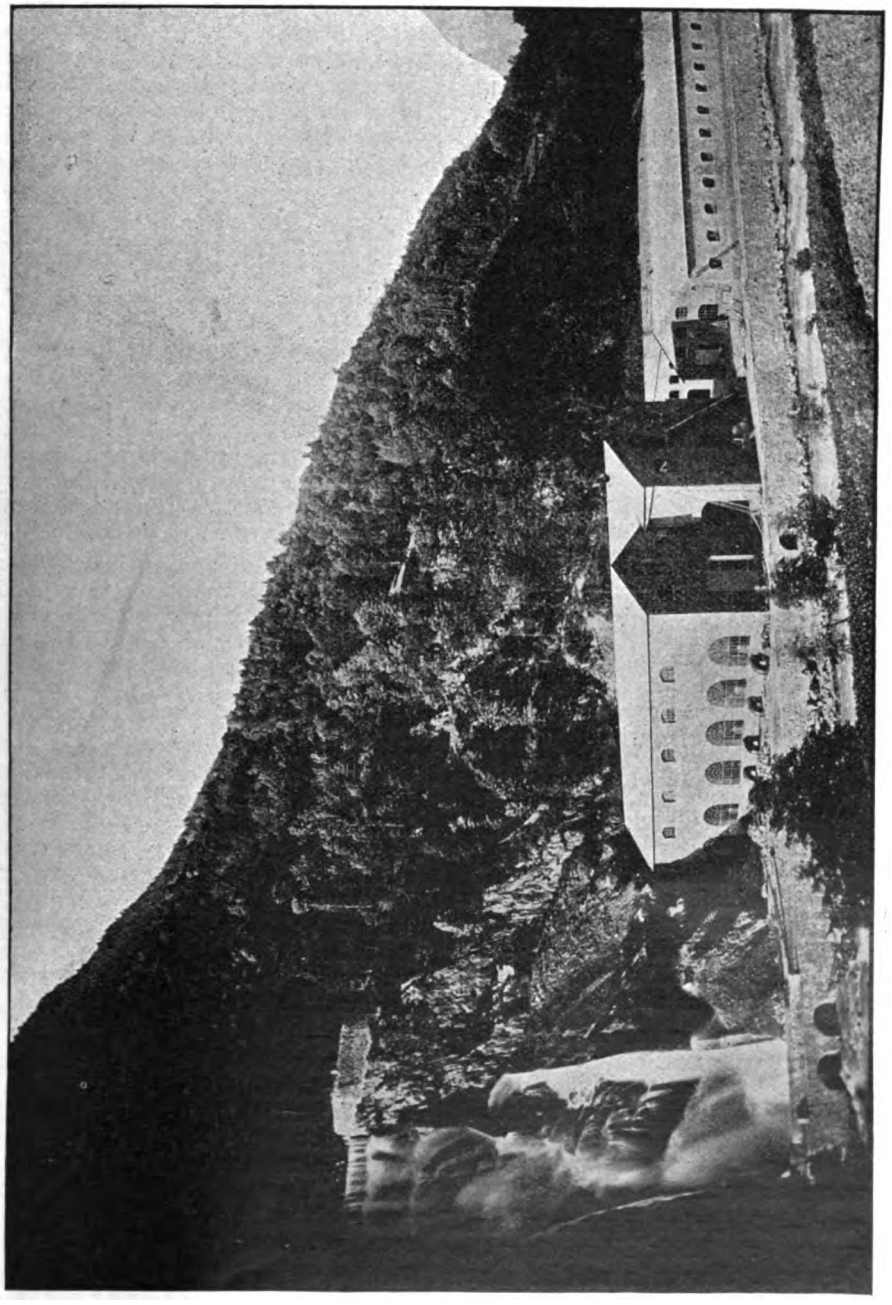


FIG. 2.—ELECTRO-METALLURGICAL PLANT AT LIVET.

pelled to seek other more profitable outlets for their power. The production and price of ferro-silicon are now regulated by a central Sales Bureau.

Iron and Steel.—France has led the way in the application of electric methods to iron and steel manufacture, and since 1900, experimental trials upon an industrial scale of various processes and furnaces have been carried out at many

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water-power centres in that country. The Heroult, the Keller and the Girod electric furnaces and processes for steel production, have been the most successful in these early trials. These three furnaces are now being employed in France for iron and steel production upon an industrial scale, with considerable success. The Heroult process is in regular operation at La Praz, and Fig. 1 shows this type of steel furnace being tilted for discharge at the works. The Keller furnace is being employed at Livet (Fig. 2). The Girod furnace is of the crucible type, and is more suited for the production of special alloys of steel—with the rarer metals. The chief works employing this furnace is situated at Ugines in Savoie.

No very reliable statistics are available for publication relating to the present production of iron and steel by electric furnace methods in France. Heroult, at the end of 1903, stated that 2,500 tons had been produced by his method in France, since the experimental trials originated. A commission of experts, appointed by the Canadian Government, has investigated the Heroult and Keller furnaces and processes during 1904, and has reported favourably concerning their prospects in places where cheap electric-power is available for use. Power at $10 per h.p. year is required however to render them financially successful.

Lead.—White lead is being produced by the Oettli electrolytic process, at a water-power centre in the Pyrenees—but no details have been published concerning the capacity or output of this work.

Zinc.—The extraction of zinc from its ores is carried on electrically in France at two places, by the Salgués and Ellerhausen processes. Limits of space forbid any detailed description of them, and no figures relating to the size and output of the works are available for publication.

Germany.—*Aluminium* is manufactured in Germany, at Rheinfelden, by the Heroult process, the works at this place having 5,000 h.p. available for the manufacture.

It is unlikely, however, that the whole of this power is devoted at present to aluminium production, as the Neuhausen Aluminium Company, which controls this works and three others, carries on many branch manufactures, and quite recently has arranged to work the Heroult steel process in Germany. No figures for the aluminium production of the Rheinfelden works have been published since it commenced operations in 1899.

Calcium Carbide is made at two of the Rheinfelden works, at Bitterfeld, at Frankfort, and at other places in Germany, but no reliable information concerning the output of these works can be obtained. The estimated consumption of calcium carbide in Germany in 1904 was 20,700 tons, and the estimated production was 13,300 tons, leaving 7,400 tons to be imported. The price of carbide has fallen during the last two years on the Continent, and the production and sales in Germany are now arranged by a syndicate which controls nine-tenths of the productions in that country.

Copper.—The electrolytic copper refining industry in Germany is represented by nine refineries, producing according to Ulke, only 2.75 per cent. of the total world output of electrolytic copper. The oldest and most important are the refineries at Hamburg, and at Oker in the Harz Mountains; a third being that of the Mansfield Copper Company, in the same district. The German refineries are all small, the development of the industry being hindered by the causes operating in the same way in England and France. The Elmore process is represented by a works at Schladern, which has been only moderately successful. A copper extraction works, using the Hoepfner process, is operated at Papenburg.

Glass.—Attempts are now being made in Germany to employ the electric furnace for glass manufacture, and a small experimental furnace, constructed by Becker and Voelcker of Cologne, has been undergoing trial for some time past, at Plettenberg in Westphalia. No details of the results obtained in these industrial trials, have yet been published, but in the writer's opinion the prospects of success are not brilliant.

Iron and Steel.—Germany has not carried out any of the pioneer work in connection with the application of electric methods to iron and steel production, and in this industry German electro-metallurgists have been content to follow

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in the footsteps of their brethren in France. Arrangements have been made during 1904, however, for the introduction of the Heroult and of the Gin processes and furnaces into Germany, and plants operating these upon an industrial scale will probably be in operation during the present year.

Ferro-alloys of chromium, manganese and other rare metals are produced by the Goldschmidt Aluminium process at Essen.

Lead.—White lead is reported to be produced by the Luckow process at Cologne, sodium chlorate and sodium carbonate solution being employed as electrolyte, with hard lead cathodes and soft lead anodes. Similar electrolytic methods are stated to be in use for producing chrome yellow and other pigments, but no details can be obtained regarding the extent or success of these manufactures.

Nickel.—This metal is produced by the Hoepfner process at the works of the Allegemeine Electro-metallurgische Gesellschaft at Papenburg. The ore in this process is leached with a solution of cuprous and calcium chlorides, and the copper and nickel are separated from the resultant liquor by electrolysis, under different conditions as regards temperature current, density, and e.m.f. In 1901, 150 tons of nickel were produced by this process at Papenburg; and in April 1902, the output had been increased to 800 kgs. nickel per day. Since that date no figures for the production have been published.

Tin.—Germany was the first country to develop and work the electrolytic process of stripping the valuable metal from scrap-tin and old cans, and the industry is now firmly established.

There are between five and eight factories engaged in this industry, and the annual consumption of scrap in these works is reported to amount to 30,000 tons. The most important works engaged in the industry is that of Goldschmidt at Essen. The process employed in these German tin-stripping works, is based upon use of sodium hydrate as electrolyte. An electrolytic method of recovering the tin from tin-slags—is in use at the works of Robertson and Bense, at Tostedt.

Zinc.—Pure zinc is not now produced, so far as the writer is aware, by electrical methods in Germany, although the earlier trials of the Hoepfner process (now in operation at Winnington in England, and at Hruschau in Austria) were made at Furfurth in the years 1895–1897. The development of the process at this place did not occur, owing to financial and personal difficulties. Electro-galvanising is carried on at several works in Germany, but few details of these plants have appeared in print.

Electricity direct from Carbon.

By C. EDGAR ALLEN, A.I.E.E.

(*Concluded from p.* 603, vol. ii.)

THE method of utilising the energy of carbon as sketched out by Reed differs from the foregoing systems in that the electrolytic cell forms a unit in a cycle of operations having for their object the regeneration of the materials consumed. The apparatus is outlined in Fig. 6.

It consists of a retort which contains two materials, viz., sulphur, and carbon, further on being a pack of stones on which water from the funnel is allowed to drop. Sulphur is burnt in the furnace underneath the resulting sulphur dioxide passing out as shown.

The vaporisation of the sulphur in the retort leads to a combination with the red-hot carbon to form carbon bisulphide, which is decomposed by the steam formed at the pile of stones into H_2S and CO_2. This mixture is led into water to form a solution of H_2S, while the sulphur dioxide escaping from the furnace is similarly dealt with to form a solution of sulphurous acid. These two solutions are passed to two separate divisions of a containing vessel separated by a porous division, and containing carbon electrodes. The diffusion of the liquids through the porous partition sets up a reaction as a result of which sulphur is regenerated and a small e.m.f. is obtained.

Another and more recent example of a similar system is furnished by the Jone process, in which the attackable electrode is of tin. The cell is furnished with an accessory apparatus, the function of which is to regenerate the tin by certain thermic reactions, and it is for this purpose that the carbon is supplied and consumed.

Another feature is the regeneration of the depolariser — mercuric oxide—from the metallic mercury obtained in the cell by the reduction of the depolariser. The mercury

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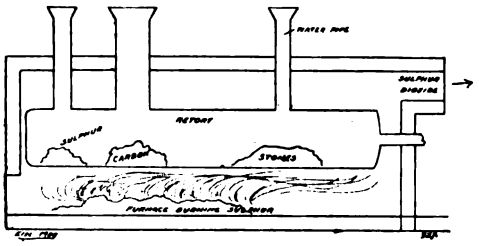


FIG. 6. REED'S CELL.

is converted into nitrate by treatment with nitric acid, which latter is again recovered by oxidising the nitrous vapours produced, in the presence of steam and atmospheric oxygen.

Thus the inventor claims that none of the substances entering into the reaction are used up except the coal and the oxygen of the air. The tin is recovered from the oxide by reduction with coal; mercuric oxide is regenerated from the metal by treatment with nitric acid, and the nitric acid is regenerated by oxidation with atmospheric oxygen. The cell consists of an outer vessel (A, Fig. 7) of nickel-plated iron or nickel steel containing as positive electrodes the tin plates D, which are suspended from the cover C, and are in metallic contact therewith, so as to make the metal cover part of the positive element. A porous carbon cup B, suspended from the cover C, forms the negative element. Mercuric oxide forms the depolariser, and an aqueous solution (2 – 1) of caustic potash, maintained at a temperature of 160° C the electrolyte. The tin of the tin electrodes is oxidised to stannous oxide, which despoits on the electrodes, and is removed by brushes E, the stannous oxide dropping to the bottom of the cell, from which it is removed from time to time. In order to prevent the depolariser from becoming exhausted, a stirrer F is provided within the carbon cup. The metallic mercury formed by the reduction of the depolariser is drawn from the carbon vessel B, by means of a syphon H. The mercury recovered is dissolved in nitric acid, and the mercuric nitrate heated to convert it into fresh oxide as described, the acid vapours evolved being treated with air and steam to regenerate the nitric acid. The stannous oxide on removal from the cell is reduced to metal in a flat hearthed furnace by means of coal, and the surplus heat used for effecting all the reactions previously described. Systematically arranged the plant consists of from thirty to sixty cells, formed into a battery, placed in a chamber forming a part of the flue provided for the escape of the products of combustion from the stannous oxide reduction furnace (J, Fig. 2). The feet of the cells are sunk in a bed of sand, gravel, or mineral wool K to keep the bottoms insulated. The heat residue remaining in the gases, after passing through the heating chamber is utilised for heating the air contained in the coil L of the air duct, which feeds the furnace. The products of combustion issuing from the reducing furnace M, pass along the flue N, first raising steam in the boiler O, then through the flue spaces P and Q, heating a horizontal drum R, containing the mercuric nitrate. The mercury in the cells is forced into the reaction vessel S, where it is mixed with nitric acid and heated by steam from the boiler shown, forming mercuric nitrate, which is discharged into the drum R, where it is broken up by heat, forming mercuric oxide. The latter is removed from the drum by a crank driven conveyor. The nitrous fumes evolved in the drum and pan pass into the condenser T, which is supplied with hot air by a fan, yielding nitric acid again, which is collected in a porcelain vessel. The inventor* states that the e.m.f. of each cell is 1.06 volts, and that the current strength of a cell holding 1.5 gallon of liquid is about 23 amperes, with an external resistance of .02 ohm. He furthermore claims that the efficiency of the cell itself is 85 per cent., and of the whole apparatus of several hundred horse-power capacity, 66 per cent. of the latent chemical energy of the coal. The latter figure, Mr. Jone arrives at by the following process of reasoning. The efficiency of the reduction of zinc compounds by means of coal is about 2.6 per cent. As only one-half of the energy of the zinc is obtained in the ordinary zinc cell, the latter represents only about 1.3 per cent. of the energy of coal consumed. In the reduction of stannous oxide, however

* *Cf. Western Electrician*, November 1903.

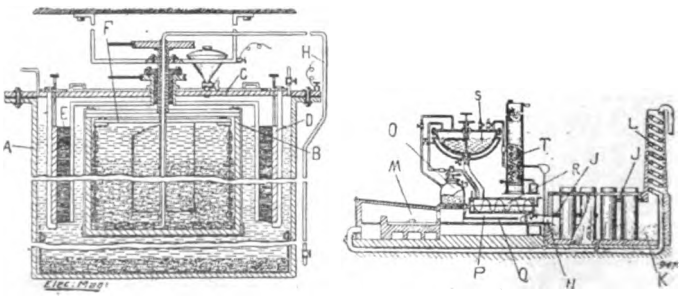


FIG. 7. JONE'S CELL.

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the energy of the carbon monoxide is utilised, carbon monoxide reducing stannous oxide, but not zinc oxide. The efficiency of the stannous oxide reduction is, therefore, increased from 2.8 per cent. to about 10 per cent., and furthermore, as this reduction takes place at a temperature but half as high as that of the zinc reduction, the heat losses are reduced from 90 per cent. to 45 per cent., which increases the efficiency from 10 per cent. to 55 per cent. Again, as the reduction of freshly precipitated stannous oxide requires but half the time that it would require if it were a native ore, the waste is reduced from 45 per cent. to 23 per cent., or the efficiency is increased to about 77 per cent.

As additional evidence of this reasoning the inventor states that when tin stone, *i.e.*, impure stannic oxide, is used in place of finely divided stannous oxide an efficiency of 25 per cent. is obtained in the reduction of the metal, which makes the efficiency of the battery 25 per cent. of 85 per cent. = 21.5 per cent. But, as the reduction of the lower oxide of tin requires a temperature of only 500° C., the heat losses are again reduced by one-half. This apparently represents the efficiency of the apparatus at about 53 per cent. Whether this battery will fulfil all the claims made for it remains to be seen, but it would appear that certain of Mr. Jone's figures relating to the heat losses in the metallurgical processes are at least capable of revision, as according to Reed, who refutes the conclusions reached by Jone, if, to an ordinary zinc battery is adjoined a suitable furnace for regenerating the metal, as good, if not better results, can be obtained.

ELECTRO-PHYSICAL NOTES.

Dispersion of Electricity in Hot Air.

An investigation by Mr. E. Brunner, published in No. 13 of *Annalen der Physik*, is intended to determine the conductivity taken by hot air at atmospheric pressure, on account of spontaneous ionisation. In order to obtain a real state of equilibrium, corresponding to a definite temperature, the whole of the air between the dispersion body connected to the electroscope and the grounded metal, was raised to a constant temperature, when, on account of the heating effects undergone by the metal, the larger part of the conductivity was found to be due to the metal. The following results are, therefore, relative to the conductivity taken by hot air in contact with metals at the same temperature.

The dispersion up to a certain temperature was found to be independent of the temperature and the metal, while rapidly rising above this temperature (up to about double its value for a rise in temperature amounting to 15°), and becoming greatly dependent on the material of the dispersion body. Fresh metals (platinum, silver, brass) will disperse negative electricity much more rapidly than after having been annealed for some time, when platinum and silver become nearly identical in behaviour, showing the same dispersion of positive and negative electricity. Copper oxide, calcium oxide, and hydrogen are found considerably to increase the positive dispersion, while at higher temperatures the opposite seems to be the case.

Some Phenomena with Electrical Discharges.

At a recent meeting of the German Physical Society, Professor E. Goldstein made an interesting communication on some phenomena in connection with electrical discharges, and especially with discharge of an induction coil in an atmosphere of nitrogen at a pressure of some cm. in fairly wide tubes (2½ to 3½ cm. in diameter), the discharge tube being cooled in liquid air. The anodical light of the discharge in uncooled tubes is a narrow band of a yellow colour, some cm. in length (becoming reddish in the case of very small additions of water vapour or free oxygen), whereas this light band becomes lengthened considerably until it nearly touches the cathode, as soon as the discharge tube is immersed in liquid air. At the same time the colour gradually varies, taking eventually a greenish-yellow shading. The band of light finally transforms itself into a thick, light column, filling up nearly the whole interval between the anode and cathode. In tubes that are not cooled the spectrum of the luminescence is identical with the familiar nitrogen spectrum, and that of the luminescence transformed by immersion in liquid air contains only the characteristic bands of nitrogen in the red, yellow, and half of the green. In the remainder of the spectrum, appears a number of new bands. Now the author is inclined to think that this transformed spectrum is that of pure nitrogen, freed from the last truces of oxygen under the influence of the low temperature. He draws attention to the intimate connection between the light column of cooled tubes and certain other forms of discharge. In the spectra of the light column is stated, in addition to the constant bands, the presence of some well-defined lines belonging to the spectrum of the metal the cathode is made of, this metal being vaporised in the cathode light. As this vaporisation takes place even with scarcely volatile metals, such as platinum and iridium, it should afford a novel process for obtaining readily and rapidly and with a considerable intensity, the spectra of heavy metals.

Momentum in the Electric Field.

In a recent number of the *Philosophical Magazine*, Prof. J. J. Thomson gives some simple illustrations of the principle which had been proved by him and set forth in his "Recent Researches," that momentum as well as energy is distributed throughout the electro-magnetic field, and that changes in the momenta of magnets, of circuits conveying electric currents, and other material systems in that field are accompanied by equal and opposite changes in

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the momentum of the field itself. Thus the system consisting of the field and the material systems in it, form a self-contained system the momentum of which remains constant in magnitude and direction. If the view be t ken that the effects in the electro-magnetic field are to be explained on dynamical principles by the agency of a medium filling the field, the conception of momentum in this medium is as essential and as fundamental as that of energy. The author shows how the application of this principle leads to a simple method of calculating the force acting on a charged point which is moving in a magnetic field. He also applies the same principle to the determination of the pressure of radiation, and shows how it may be extended so as to include the case of refraction. Radiation must necessarily give rise to pressure when it is refracted; for the momentum in the medium is in the direction of propagation, and therefore, when this direction is changed there is a change in the momentum in the medium. It follows from this, by the principle of the conversation of momentum, that the refracting substance must undergo a change in momentum.

LONDON PHYSICAL SOCIETY.

A PAPER on the "Action of a Magnetic Field on the Discharge through a Gas" was read by Dr. R. S. WILLOWS on January 27.

It has been shown previously that a transverse magnetic field, if applied at the cathode, may in some cases reduce the potential difference at the terminals of the tube. It is shown in the paper that the pressure at which this decrease commences corresponds to the pressure at which the voltage required to maintain this discharge, under normal conditions, is a minimum. This is also found to be the pressure at which the positive column is first completely striated. Reasons why such action takes place are given.

A paper on the "Action of Radium on the Electric Spark," by Dr. R. S. WILLOWS and Mr. J. PECK, was read by Dr. Willows. In certain cases the Authors have found that the spark from a Wimshurst machine is extinguished by the action of the radiations from radium and that the current passing is decreased. The action is altogether different according to the direction of the discharge. Using a spark-gap longer than 2 cms. and making the larger knob, of the machine used, positive, the radiations had practically no influence. With the smaller knob positive the radium, in most cases, extinguished the spark. The phenomenon is found to be due to the action of the β rays. Röntgen rays do not produce this effect, even if their ionising power at the spark-gap is some thousands of times greater than that of the radium. Lenard rays are, however, effective.

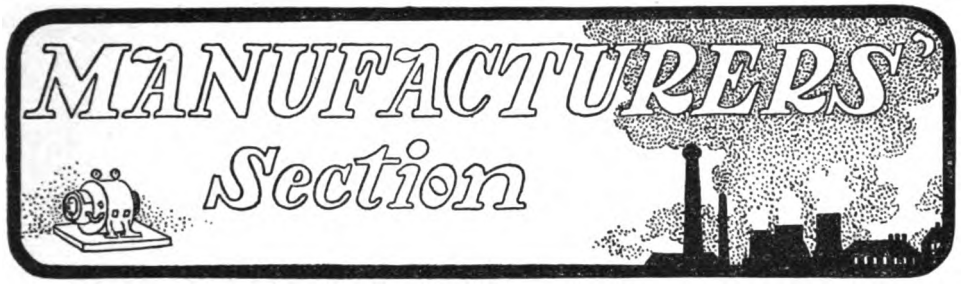
Prof. F. T. Trouton expressed his interest in the paper, and referred to the fact that the action of the radium depended upon the direction in which the current was passing. He could see no obvious explanation of this.

A paper on "The Slow Stretch in India-rubber Glass, and Metal Wires subjected to a Constant Pull" was read by Mr. P. Phillips. When india rubber is subjected to a sustained pull of constant amount it yields at quite a large rate, the stretch at any time (t), after the establishment of the pull, being given by $x = a + b \log t$, a and b being constants for the particular pull exerted. For different pulls b is proportional to the pull. When the pull is removed the india-rubber slowly returns to its original length, the extension still remaining at a time t_0 after the removal being given by $x = b \log \left(\frac{t}{t_0}\right)$, t being the time which has elapsed since the pull was established. When one pull is added at a definite interval after another, the effect of the two pulls is not exactly the sum of the effects which would have been produced by each separately, but it approaches very nearly to this after a time. When india-rubber is stretched to a fixed length and retained there, the pull required to maintain that stretch diminishes with time and is given at any time (t) after the initial stretch was established by the law $P = a - b \log t$, b being proportional to the magnitude of the initial stretch. The temperature coefficients of expansion and contraction of india-rubber in tension are quite different. The decrement of the amplitude of vibrations in india-rubber obeys the ordinary law. The first two results, for the slow stretching and slow recovery of india-rubber, have also been established for glass fibres subjected to sustained pull, but the magnitude of the slow yielding is very much smaller. When annealed wires of copper, silver, gold, or platinum are subjected to a sustained pull they behave in some ways similarly to india-rubber and glass, but there are some very decided differences. If the pull is greater than a certain amount (in the actual experiments about one-third to one-quarter of the breaking weight) the stretch at any time (t) after the establishment of the pull is given by the same law $x = a + b \log t$, but below this value of the pull b is zero. This law obtains up to the breaking strain of the wire, b increasing very rapidly a little before the breaking-strain is reached. When the pull is removed, there is no appreciable slow recovery like that occurring in india-rubber and glass. Iron and steel wires show themselves to be exceptions to these rules.

Dr. Chree remarked that a great many experiments had been made upon the subject, and that both exponential and logarithmic formulæ had been proposed to fit the results. It was possible to get very different formulæ which would agree with the results of experiment with equal accuracy. He thought it was important to distinguish between viscous yielding and elastic creep followed by recovery.

Mr. R. Appleyard expressed his interest in the paper and especially in the part dealing with experiments on india-rubber. The author had used vulcanised rubber, and the properties of this would not remain constant over any length of time. He had previously suggested that in experiments such as those described the value of Young's Modulus might be variable. This idea was borne out by the results obtained by Mr. Phillips. One of the chief difficulties was the accurate determination of the diameter of the cord or wire under investigation.

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A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section at end of Magazine.

The Lancashire Dynamo and Motor Company.

ITS WORKS AND ELECTRICAL PRODUCTS.



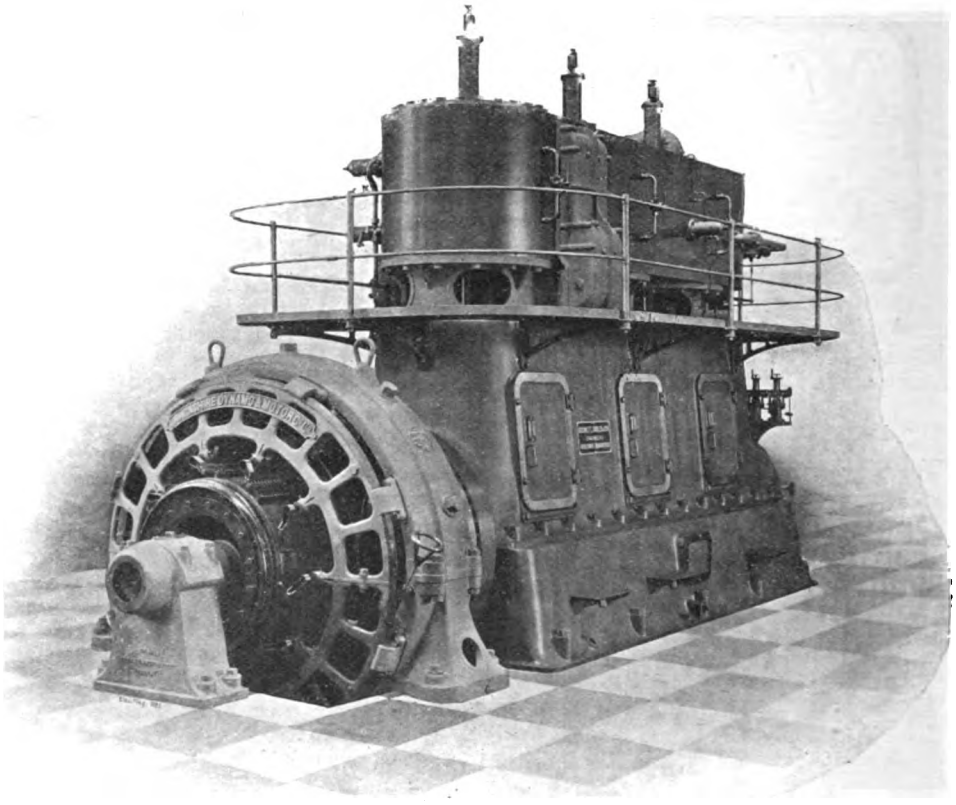
Introductory.—At one time in the history of electrical engineering the manufacture of motors and dynamos was undertaken in a small department of a general engineering works. At that period no one had the idea of specialising this class of electrical product, and this notion prevailed until a few years ago, when it was observed that a distinct and separate field existed for the production of these important machines. The chief advantage of decentralisation is undoubtedly with the consumer, who has placed at his disposal better brains, more organised labour, standard designs and interchangeability of parts. The mere fact of an organisation concentrating its efforts on the perfection of certain standards to the exclusion of everything else must appeal to him, and should attract his attention to the finished product. Specialisation to be beneficial must be carried beyond the field of theory into the sphere of advanced practice, and this is becoming more and more the recognised order of things.

In our recent visit to the Trafford Park Works of the Lancashire Dynamo and Motor Co., the evidences of this movement were strongly brought to our notice, and we are pleased to present our readers with some account of the operations of a concern which has made a speciality of dynamos and motors for some years past. Its organisers are to be congratulated on the zeal with which they started and have extended the works, though their present flourishing condition must be the best form of recompense the management could have wished for.

Historical. — The Company started about the middle of 1900 with some thirty men, and, needless to say, its control is British, while the capital has been drawn from a similar source. While the permanent works were building at Trafford Park, temporary operations were carried on in Croft Street, Pendleton, where drawings were prepared and patterns for all standard sizes of machines built. This temporary start proved very valuable when a move was made to the permanent works. The rapid expansion of the Company's operations is the best possible indication of its present commercial condition. The first extension was commenced in March 1903, and in September of the same year two further additions to the buildings were made, while the number of hands has been increased to nearly 500 and further extensions are in progress.

The Works.—We do not wish to weary our readers with a stereotyped account of the buildings and their equipment. The works have been compactly laid out and with an eye to future extensions which will make them even more homogeneous. Frequently industrial establishments when extended become

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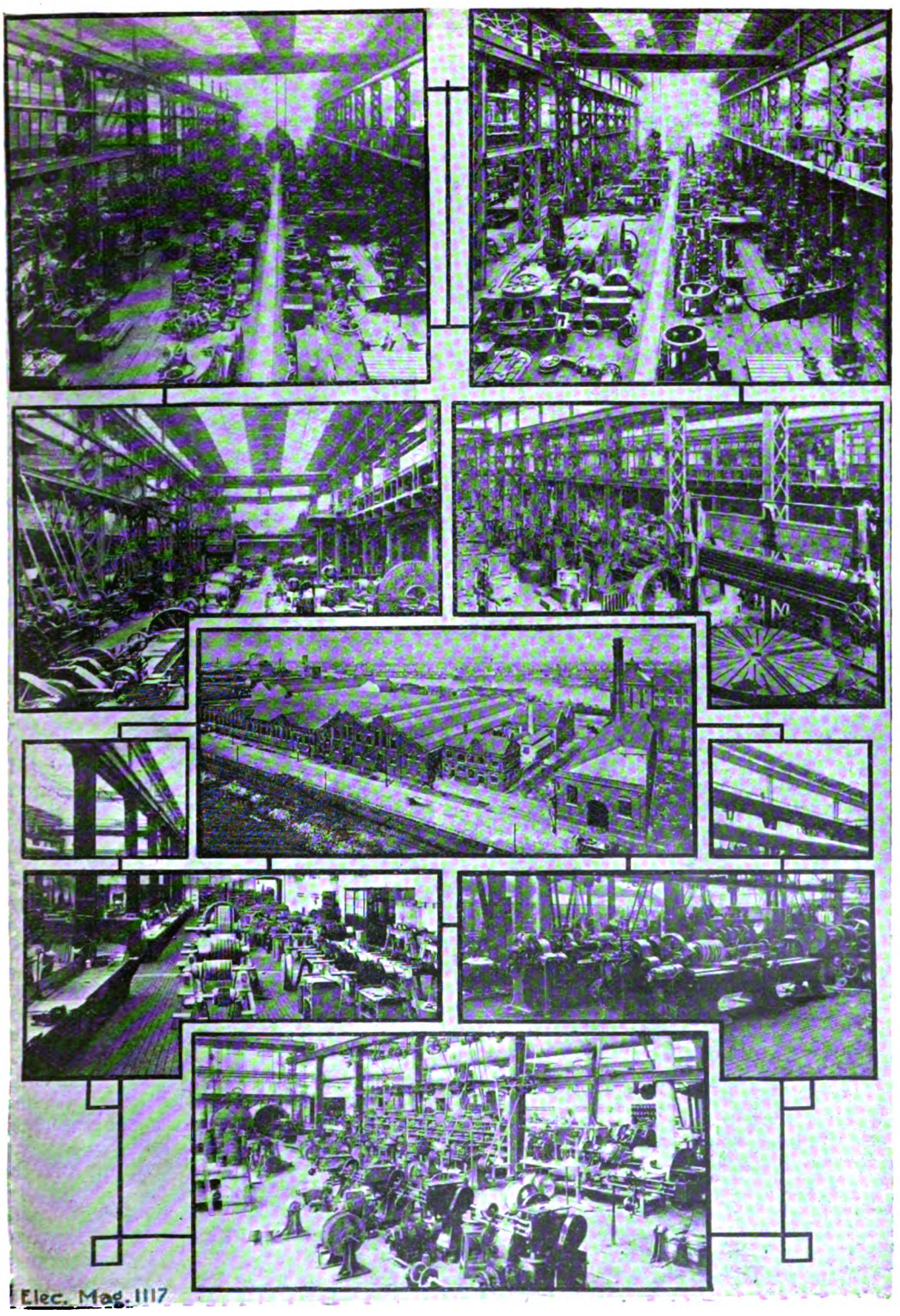


10-POLE SHUNT WOUND GENERATOR 750 KW. AND 1,100 H.P. BROWETT AND LINDLEY ENGINE.
(*Built for Govan Corporation.*)

scrappy and scattered, but this cannot be said of the works in question. There is a large machine department in which all heavy work is conducted, the shop comprising two bays, each 250 ft. long by 65 ft. wide. The extensions have constituted a number of bays at right angles to the old works, and in these are the armature, fitting, and capstan departments. All shops are exceptionally well lighted and are heated on the plenum system. Each bay is served by high-speed electric cranes fitted with the Company's own motors, the capacities varying from five to twenty tons. A small tramway runs throughout the shops and facilitates the speedy transport of material. The Ship Canal Railway runs into the works, and in addition there is a good road leading to the Manchester Ship Canal. Great care and judgment has been exercised in the selection of the machine tools, the majority of these being horizontal boring mills and capstan lathes. The greater number of tools are driven by separate motors, a speed range of 3 to 1 being obtained with these on the shunt field. It has been found in practice that this range is sufficient for all ordinary purposes, and that complicated two commutator motors and three wire balancers are unnecessary. Power is obtained from the Trafford Park Power and Light Supply Co. at rates which discouraged the original idea of installing a separate plant.

The general scheme of departments contributes to the greatest economy in operation, and the quickest passage of the various parts from the raw material to the finished article. It was evident to us during our inspection that everything which modern enterprise had done towards the perfecting of work-shop methods was taken full advantage of. Free from the worries of experimenting

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Aisle in Machine Department. *General View of Works.* *Aisle in Machine Department.*
Machine Department. *Boring Mills, Machine Department.*
Armature Department. *Winding and Drying Department.* *Motor Driven Lathes, Machine Department.*

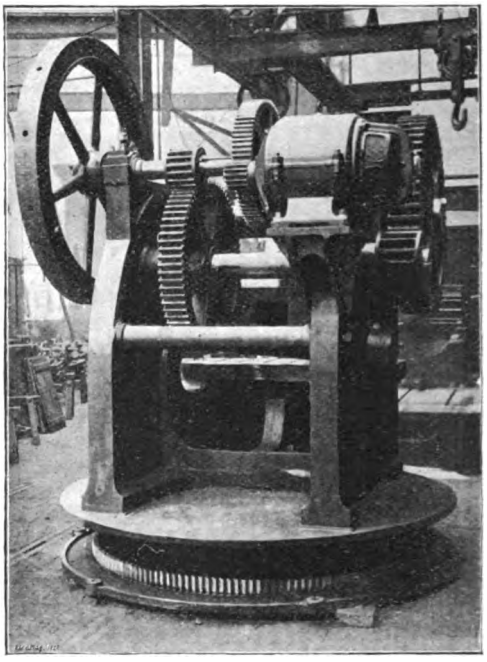
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and research in unprofitable fields, the Company has been able to settle itself to the elaboration of methods and processes by which dynamos and motors can be quickly and economically produced.

The Departmental System. — As we have mentioned before, the works are divided into various departments. In each of these certain specific operations are organised and performed, each section forming a unit which can expand or contract within its own limits according to the work passing through it.

Machine Department. — The various operations of machining field yokes, motor carcases and stator frames, are carried out in the machine department or what comprised the old works. This department is fitted with all the heavy tools, among these being an 18-ft. boring mill, an 8-ft. 6-in. lathe and an 18 ft. by 6 ft. planer. The shop is surrounded by a gallery upon which a number of smaller operations are performed. Underneath this at one end of the second bay is a well-equipped tool department in which tools are not only stored but also ground and repaired. This section is in the hands of an expert tool maker, who is entirely responsible for the care of all tools. A check system is in vogue by which a man surrenders a brass label in exchange for a tool, the label being hung against the space from which the tool has been taken. The same department looks after the gauges, which are carefully set on a special measuring machine. Work is done to the ten-thousandth of an inch, and by carefully checking the gauges absolute interchangeability is assured. We may say indeed that interchangeability of parts has been brought up to a fine art by this method, and the Company must be well repaid for its outlay in plant enabling this degree of accuracy to be arrived at.

Armature and Fitting Department.— The winding of armature and field coils, the building up of commutators and the fitting together of the completed parts is carried out in the extension works. In the six bays the various operations from the simplest to the more complex are conducted, everything tending to drift towards that spot where the machines are finally assembled. We noticed a number of compact winding machines, each driven

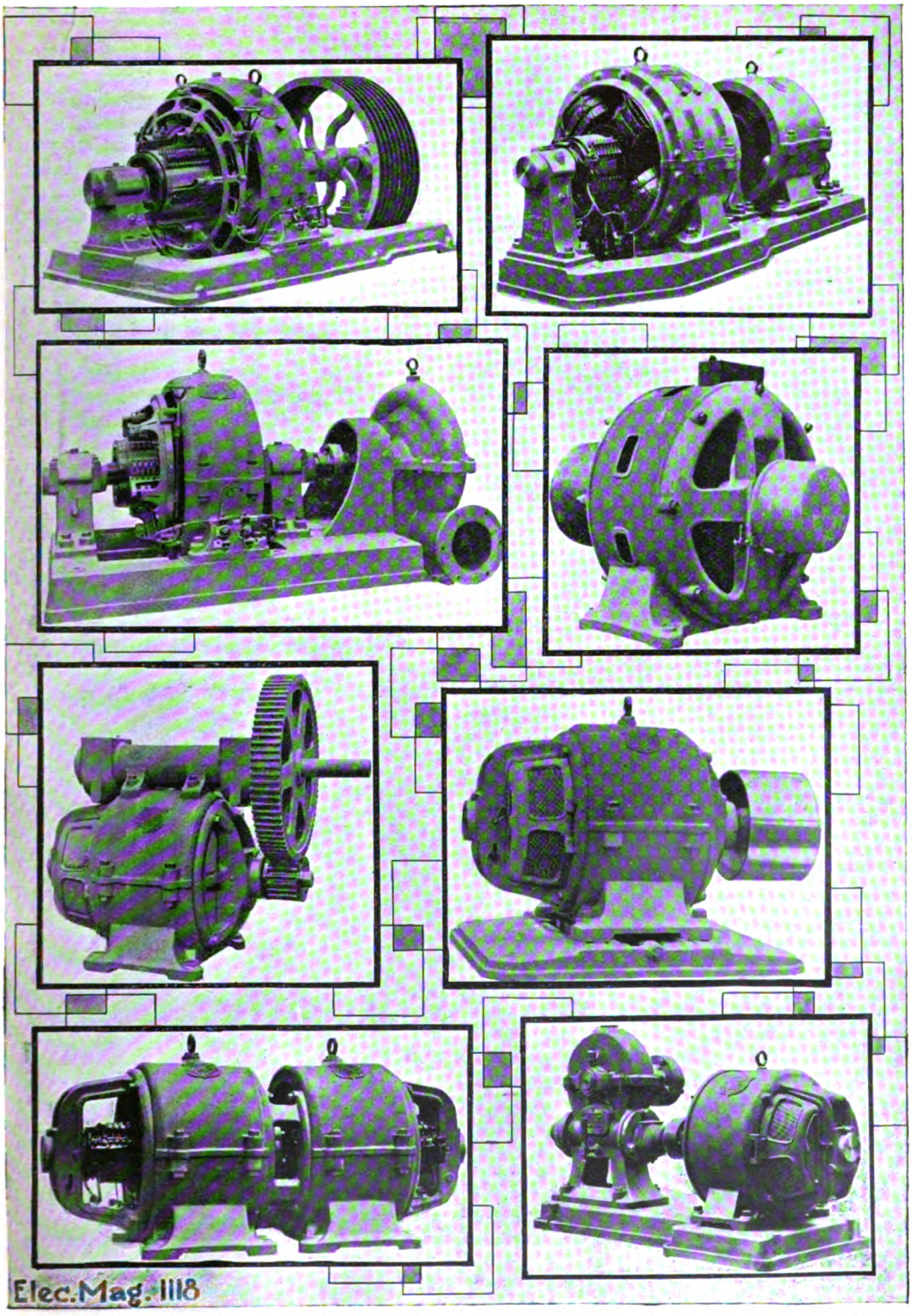


MOTOR-DRIVEN PUNCHING AND SHEARING MACHINE.

by its own motor as well as numerous lathes operated in a similar manner.

Testing Department.—The testing department is at present situated in the old shop where the machining is carried on. It is intended to move this to a large new shop adjoining the works but separated from them by a thoroughfare appropriately dubbed Dynamo Road. There are two large testing beds, one about 40 ft. square and one 40 ft. by 30 ft. In conjunction with these there is an office containing standard testing instruments, and the usual switching arrangements for obtaining various loads. We noticed a transformer, which we were informed gives pressure up to 20,000 volts. A system of labelling both the machines and their various parts is in use. By this the condition of any particular piece of apparatus is known. For instance, an armature on leaving its department as tested and correct is ticketed with a green label. If in any way defective a red label is attached, and it is returned to the Armature Department to be repaired. If satisfactory, a complete machine has affixed to it a blue label in which condition it is passed to the painting and packing department.

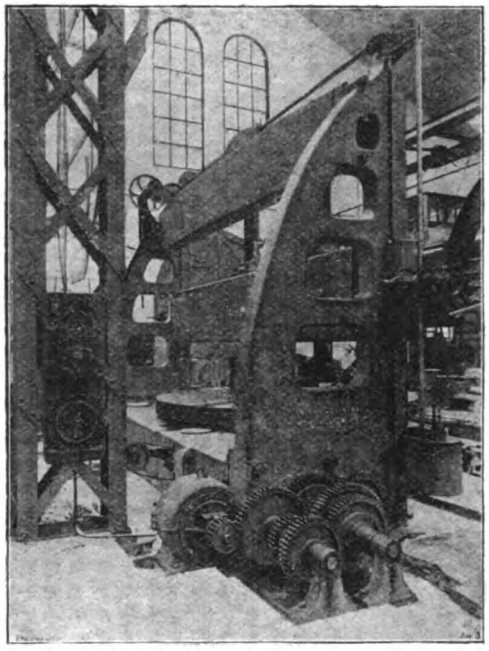
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Rope Driven D.C. Unit.
D.C. Motor and Centrifugal Pump.
Backgeared D.C. Motor.
Three-wire Balancer.

Traction Reversible Booster.
Polyphase Induction Motor.
Standard D.C. Motor.
D.C. Motor and Reducing Gear.

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MOTOR DRIVING BORING MILL 18 FT. DIAMETER.

A final inspection is made by the testing department, which attaches a yellow label, this being its *ipse dixit* of the machine's completeness.

Miscellaneous.—Adjoining the offices are a smithy, brass foundry, and a large dining-room accommodating over 500 men. Over the latter is a roomy pattern shop in which standard patterns are made and stored.

GENERAL ELECTRICAL PRODUCTS.

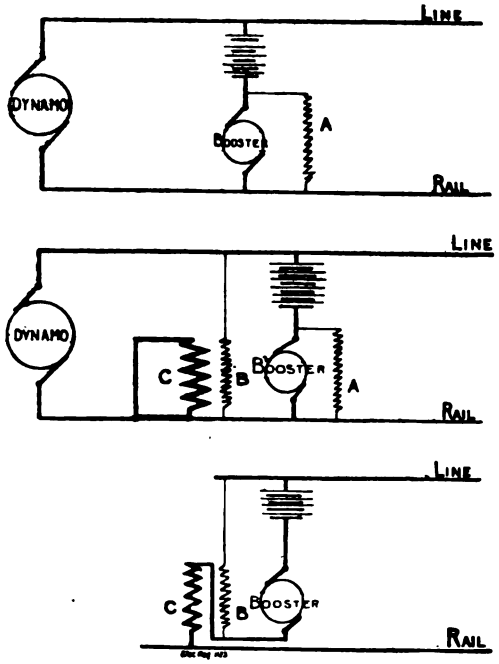
As its name implies, and as we have previously observed, the Company is only concerned in the manufacture of dynamos and motors. Both alternate- and direct-current forms have been standardised, the sizes varying from 1 to 1,000 h.p. in motors and from 2 to 1,000 kw. in generators.

Standard Direct-Current Machines.—The direct-current machines, both dynamos and motors, are contained in a cast-steel case with solid poles integral with the carcase. A special laminated pole-tip is screwed on after the field coils have been slipped into position. These tips are faced up in a special grinder, an electro magnet being used to hold the laminæ against the emery wheel. The field coils are fitted with terminals so placed that should the spools be removed for repairs any error in replacing them is practically impossible. Neat, flexible connections are made from these terminals to the adjoining coils and to the brush gear. The armature core is built upon an iron casting which also carries the commutator. The shaft, after being carefully trued by grinding, is pressed through this casting and firmly keyed to it. The core plates are assembled in the usual way being finally clamped up solid by end plates. A special machine has been put down for opening out the core slots and smoothing them up ready for winding. This dispenses with the necessity for filing, and saves a considerable amount of time and labour. Mica tunnels are used in the slots, these tunnels being specially built up on the works. The armature coil, after being dipped and dried, is dropped into the slot and firmly held in by a fibre wedge. The commutator, built up with mica insulation between its segments, is firmly clamped together and pressed on to the core casting. The connections between the segments and the armature coils are made by special copper flexible, the ends of which are sweated in at one operation. This makes a neat job and admits of ready disconnection for testing and repairs. Two sizes of brush holders only are used, each holder comprising a unit which is multiplied according to the size of the machine. The brush is a special carbon block which is locked or released by one turn of a milled nut. The brush holders are carried by an insulated pin which is clamped into the rocker arm and is insulated from it, but without having recourse to loose bushes and washers. The bearings are spherically seated, and the main leads enter the machine casing through insulators below the main bearing. For very large machines of course a special terminal board is provided.

Standard Alternate-Current Machines.—The alternating-current generators built are of the revolving field type with radial poles bolted to the periphery of a cast-steel wheel. The field coils are wound with copper ribbon on edge. The stator is fixed and carried by a cast-iron frame in which the core and winding are assembled. We illustrate a machine of this class in our standard types of electrical apparatus this month.

Induction motors are manufactured

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CONNECTIONS OF TRACTION REVERSIBLE BOOSTER.

and largely supplied for mining and other engineering work. The smaller sizes are of the common squirrel cage pattern but the larger types are fitted with slip-rings, a speciality being made of the method of fixing these outside one of the main bearings. The leads from the motor winding are passed through a hollow part of the shaft and thus led out to the rings. By this arrangement the brushes and rings can be completely enclosed, and a safe form of alternate-current machine is thereby provided for operation in inflammable atmospheres. A much neater construction is also obtainable by this method.

Reversible Boosters.—A special feature is made of Turnbull and McLeod's reversible booster for traction work. This has been introduced to dispense with the necessity for a separate exciter and also with the idea of a more compact construction. The motor portion is a shunt-wound machine and has no special features. The booster, however, is specially wound, there being four field windings comprising :

(1) A shunt across the booster terminals ;
(2) a shunt across the bus-bars ;
(3) a series coil between the negative dynamo terminal and the negative main, and
(4) a small coil in series with the booster armature.

(1) equalises the battery and booster and bus-bar voltage; (2) increases the booster voltage but is counter-balanced by (3) when magnetising effects are equal, that is, when the line current is normal. Should the latter increase through an overload the series coil preponderates and the battery discharges. For a decreasing current the opposite effect is produced; (4) compensates for armature reaction and pressure drop in the booster.

Contracts.—At the time of our visit a quantity of important contracts were being carried out. Amongst these were specially noticed some large machines for the Acton Urban District Council. These comprise some 10,000-volt induction motors coupled to direct-current generators of 300-kw. capacity. Direct current and polyphase motors of all sizes were to be seen in various stages of construction throughout the works, and we understand that a number of large orders for these machines were being put through. We understand that the Company's variable speed motors have met with much favour in large engineering and railway companies' works, and have been widely taken up by them. Among these we may mention the Admiralty equipment of Sheerness, Malta, and Bull Point Dockyards, the Woolwich Arsenal, L. and N.W. Ry. Co., G.W. Ry. Co., Armstrong, Whitworth and Co., Hick, Hargreaves and Co., and the Metropolitan Amalgamated Carriage and Railway Co., &c.

Concluding Remarks.—Our thanks are due to Mr. A. P. Wood, the courteous manager, for giving us the opportunity of visiting the works and judging by the Company's operations in the dynamo and motor field there is very big business before it in the future. Should any be prejudiced against decentralisation in manufacture and especially in electrical manufacture, his opinion would doubtless undergo a considerable change after an inspection of this particular establishment, the organisation of which has only been effected after careful thought and considerable foresight. If we are to hold our own in the industrial electrical field, we cannot do better than copy the methods outlined in the above article, which must assuredly make for that per-

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fection of design and economy of manufacture which compel orders and meet competition on its own ground. Commercially this company has been very successful and has paid an average dividend of 10 per cent. during the last four years besides accumulating a large reserve fund.

IGRANIC RHEOSTATS.

THE Sturtevant Engineering Company, Ltd., of 147 Queen Victoria Street, have recently added a number of improvements to their single and double automatic motor starting rheostats, and are now offering to the market their latest designs under the name of the "Igranic" starting rheostats. To a very great extent the conditions which cover the design of a first-class starting rheostat have altered during the past two or three years, because corporations and supply companies have raised the supply voltages to consumers. These increased voltages made the rules more stringent for the protection of their network and customers. The new conditions necessitate new types of motor starting and controlling apparatus, and to meet these the "Igranic" starting switches have been introduced.

Briefly stated, the points which are necessary for the design of a reliable rheostat are as follows :

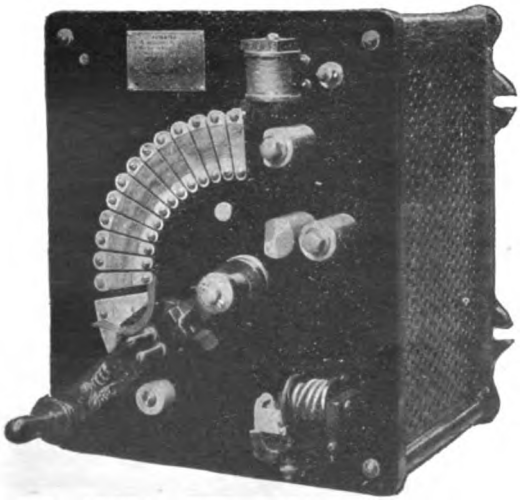
(i) A sufficient number of contacts to ensure an easy acceleration of the motor.

(ii) Automatic releases to protect the motor in the event of failure of supply, or overloading.

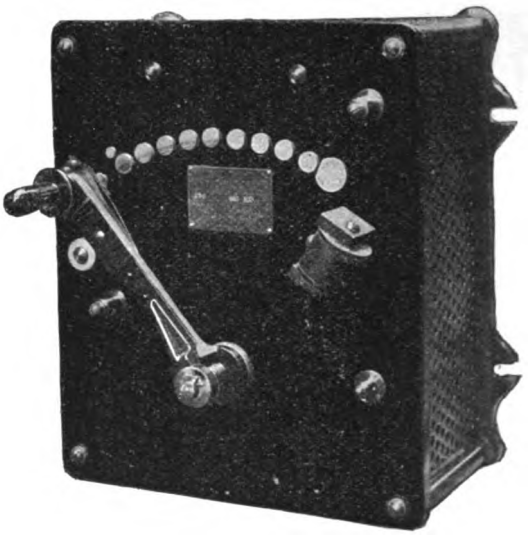
(iii) Ample carrying capacity in the resistances which must be arranged for a minimum of sparking between the moving and fixed contacts.

(iv) Accessibility in case of needed repairs.

(v) Resistance box arranged for ready inspection, and ample ventilation to prevent overheating.



STARTER WITH OVERLOAD AND NO LOAD CUT-OUTS.



STARTER WITH NO LOAD CUT-OUT.

(vi) The rheostat should be designed to give a high insulation resistance between any live part and earth.

The "Igranic" starting rheostats comprise a black enamelled slate front upon which are mounted the contacts, and a cast-iron ventilated resistance-box.

The contacts are of two kinds : (1) The button contact, for currents up to 55 amperes, and (2) the renewable contact, segmental in shape, for currents exceeding 55 amperes.

The rheostat fronts are made in two patterns, one with automatic no-volt release, which allows the contact arm to return to the off position in case of failure of supply ; and the other with automatic no-voltage release and overload cutout, the overload coming into effect when the current exceeds a predetermined amount.

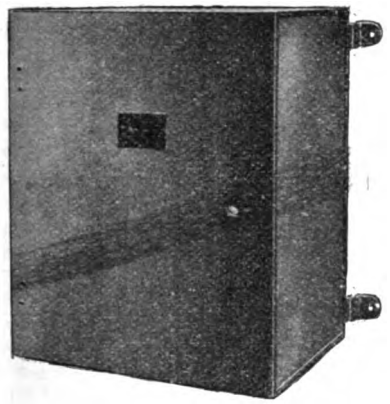
The principal feature in connection with the "Igranic" rheostat is the arrangement of the resistance-box. The slate front is screwed to a cast-iron box and insulated therefrom by insulating washers and brushes. The resistance material is wound upon asbestos tubes, these being supported by specially formed porcelain insulators. The latter are held in perforated supporting strips, which ensure a very high insulation between the resistance material and the metal box.

The connections between the contacts on the slate front and the sections of resistance are made by specially formed clips placed in chambers at either end of the resistance-box.

This arrangement is very desirable for two reasons :

(1) There are no internal connections in the resistance box.

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RESISTANCE BOX

(2) Every joint can be inspected at a moment's notice.

The top, bottom, and sides of the cast-iron resistance-box are covered by perforated sheet-metal held in position by spring clips at the corners. It is possible to open up and inspect the resistance-box without removing a single screw, and without any special tools. It is only necessary to remove the spring clips from the corners, take away the perforated sheet sides, and the whole of the interior is exposed to view.

It must be obvious from the above description that the "Igranic" starting rheostats are of simple and excellent design. They are manufactured throughout at the Sturtevant Engineering Company's London factories, with first-class materials and the best workmanship.

The switches can be supplied in three patterns, of which illustrations are given herewith and they can be supplied for series, shunt, and compound motors.

They can be supplied suitable for series, shunt, or compound wound motors.

ELECTRIC v. HYDRAULIC CRANES.

THE compiler of the average trade catalogue or pamphlet often defeats his own purpose by making his production a mere collection of palpably biased and partial statements. It is, therefore, with some relief that we turn to a booklet published by Messrs. A. Smith and Stevens of London, in which the rival claims of electric and hydraulic lifts, together with other questions relating to the former, are treated in a judicial and carefully reasoned manner, chapter and verse being given for every statement advanced.

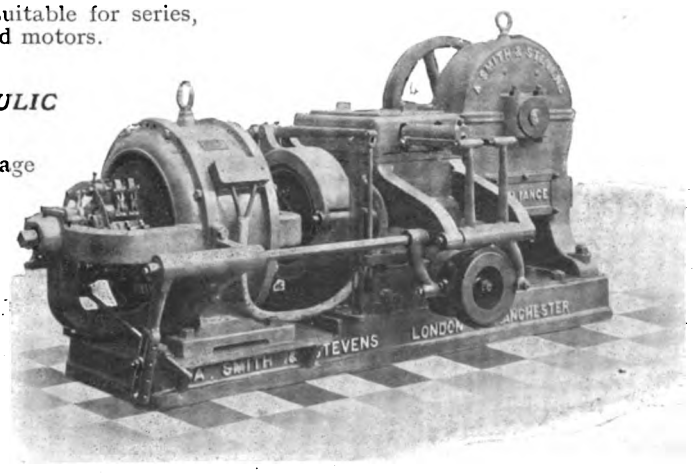
The writer opens with a consideration of the points of simplicity and prime cost, on both of which superiority is accorded to the hydraulic machine, the advantage being greatest in those cities where a public supply of hydraulic power at high pressures exists. In these centres the first cost of the hydraulic installation, as well as the permanent charges for power, are much less than in places where the low-pressure domestic supply is alone available. But the more important question is shown to be that of the cost for power to work the machine. It is obviously bad commercial policy to save, say, £50 of capital outlay per machine if the additional annual cost for power is to be three or four times the interest value of the capital saving.

For the elucidation of this proposition, several examples of actual results from practice are quoted. These were obtained from hydraulic lifts working under both high and low pressures, and from electric lifts working under various conditions of supply.

The results are collected in a table which we reproduce on page 20.

The comparative saving shown by the electric machines in relation to the high-pressure hydraulic lifts is sufficiently striking, but is quite put into the shade by the economy they effect in comparison with low-pressure hydraulic machines.

Anticipating the objection that these examples were specially selected to favour the electric machine, Messrs. Smith and



SINGLE-PHASE ALTERNATING-CURRENT MACHINE.

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TABLE I.

Comparative Cost of Working Hydraulic and Electric Lifts.

Type of lift.	Load.	Source of Power.	Travel in Feet.	Cost of Average Round Trip Up and Down in Pence.	Number of Trips per penny.	Remarks.
Electric . . .	7 cwt.	Birmingham Corporation	50	1072	136	Observed. Conditions ordinary. Current at 2½*d.* Test covered 40 round trips with full load.
Hyd. Suspended H.P.	7 cwt.	Manchester Corporation	50	.29	3.45	Calculated from Published Scale.
Hyd. Suspended L.P.	7 cwt.	Town Supply . .	50	.445	2.2	Calculated at 6*d.* per 1,000 gallons. Pressure, 50 lbs.
Electric . . .	9 cwt.	Private Supply . .	50	.066	15.	Observed. Conditions ordinary. Current at 2½*d.*
Hyd. Suspended H.P.	9 cwt.	London Hyd. Power Co.	50	.237	4.22	Calculated from Published Scale.
Electric . . .	9 cwt.	Glasgow Corporation .	50	.066	16.4	Observed. Current 2½*d.*
Hyd. Suspended H.P.	9 cwt.	Glasgow Corporation .	50	.212	4.7	Calculated from Published Scale.
Hyd. Suspended H.P.	12 cwt.	London Hyd. Power Co.	50	.287	3.48	Observed .
Hyd. Suspended H.P.	9 cwt.	London Hyd. Power Co.	50	.235	4.25	Observed.
Hyd. Ram. H.P.	12 cwt.	London Hyd. Power Co.	50	.344	2.9	Observed.

N.B.—Corrected by L. H. P. Co., 1904 Scale.

Stevens, who, by the way, are manufacturers of both types, have kept a record of the payments made for electric current by the whole of the users of their electric lifts.

These have been classified, averaged, and tabulated, together with the average cost for power of all the hydraulic machines connected to the mains of the London Hydraulic Power Company.

From these we gather that the average electric lift in a warehouse can be run for a matter of £5 10*s.* a year, and an average passenger lift for offices or flats requires less than £9 worth of current for the same period.

But the cautious purchaser will probably inquire whether the greater intricacy of the electric machine may not lead to such an outlay upon repairs as will more than wipe out the saving of power, and finally turn the scale in favour of the hydraulic rival.

Here also Messrs. Smith and Stevens, avoiding the questionable course of advancing mere opinions, give instead the results of a complete account of all repairs made to all the electric lifts which they have manufactured, including renewals of ropes. Against this, they have set the aggregate running time of the whole of these machines, and state as a result that the repairs per lift per working year have averaged £2 19*s.* only. They are also able to point to a number of machines which have run for periods of from two to six years without any repairs whatever.

These facts should convince the most sceptical that the electric lift, if carefully designed and substantially made, is fully entitled to rank with the most reliable as well as the most economical of machines.

From consideration of the general question, the pamphlet proceeds to notice the different kinds of current available, and the varying efficiencies obtainable respectively with continuous, polyphase alternating, and monophase alternating supply systems.

It is interesting to learn that successful lifts can now be constructed, worked by single-phase alternating current, the motors being direct-coupled, reversing, and starting with certainty against full load. We presume a form of repulsion motor is employed, a type in which considerable advances have recently been made.

Direct-coupled motors, starting and stopping with the lift, are compared with constantly running motors with belt-driver, much to the advantage of the former as regards economy of power. Proper provisions should, of course, be made for the protection of both armature and shunt field-windings, from the risks attending frequent starts and stops; but if that be done the risks indicated can be practically

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eliminated. A brief reference is made to the subject of selection of the best type of power for private installations in large buildings, and some useful hints are given.

The various methods of controlling electric lifts are then described and discussed. Electrical control by means of a pilot switch in the cage is recommended for high-speed passenger machines where a lift attendant is employed.

For less busy lifts, as in private houses, the more elaborate automatic machine with a push-button on each floor, interlocking landing gates, and gate switches to cut off current unless every gate is shut, is found the most suitable combination. The actual management of this machine is so simple that untrained persons can use it with safety, and we learn that recent improvements have much reduced the complication of the earlier machines, naturally rendering them less liable to stoppage from trifling causes.

Automatic-device lifts on a similar system are mentioned, and a less elaborate arrangement with two buttons on each floor where a smaller expenditure is desirable. For goods lifts, and slow-moving machines, the hand-rope control holds its own owing to simplicity and cheapness.

The *brochure* concludes with a detailed description of the numerous electrical and mechanical safety appliances which the compilers incorporate in all their machines, and among these they lay much stress on their precautions against over-winding and slack cable, two serious complaints from which they claim their machines have always been exempt.

Manufacturing Progress.

Graham, Morton and Company.—A very large coal-screening plant has recently been completed in record time at Kilnhurst Colliery, near Sheffield. This is a very extensive plant covering an area of 21,300 sq. ft., and the contractors, Messrs. Graham, Morton and Company of Leeds, must be complimented upon erecting it within the short space of eight weeks. It included screen-house, tipplers, jigging-screens, picking-belts, slack-creepers with structure and also roofs and gantries. A few figures will give an idea of the extent of the work. There were 193 stanchions, 22,876 lineal feet of 9 in. by 3 in. planking, 22,180 superficial feet of corrugated sheeting, the whole weight of the structure independent of the machinery was 300 tons.

Meldrum's Destructor Records.—Messrs. Meldrum Bros., Ltd., of Timperley, Manchester, have been creating records in electricity generation from refuse. At Burnley some evaporative tests were made from which it was found that 960,300 lbs. of water were evaporated from 266 tons of refuse. The Nelson destructor, when tested, recorded a maximum flue temperature of 2,680° F. At Preston the Meldrum destructor has been coupled to the steam mains from the Tramway Power House and the entire service of thirty cars is being run from it, on about twenty miles of route. An extension is also contemplated which will not overtax the present capacity of the destructor. The same firm has recently secured orders for new destructor plant and extensions at Middleton, East Ham, and Dublin.

The Phoenix Dynamo Manufacturing Company have completed, or on order, a number of important contracts. Among these are a 350-kw. traction generator, Cleckheaton Urban District Council, generators for Deptford Urban District Council, 708 h.p. in twelve motors for Simpsons and Company, Pimlico, 250 kw. generator for a Yorkshire colliery, 350 h.p. for four other Yorkshire collieries, 300-kw. traction generator for the Bradford Corporation, and 1,500 h.p. of motors for various customers. In polyphase work one 25-h.p. two-phase motor coupled to a 75-kw. direct-current generator. Polyphase plant of the same make has also been delivered to Birmingham and Nottingham Universities and technical schools at Lancaster, Bradford, and Birmingham. The Phœnix electric sensitive drill described in our August issue is also meeting with a large sale.

Messrs. John Gibbs and Son.—We have received a copy of the Cunard souvenir, from which we gather that Messrs. John Gibbs and Son's patent weatherproof ventilating appliances are used entirely by the Cunard Company. We give an illustration showing



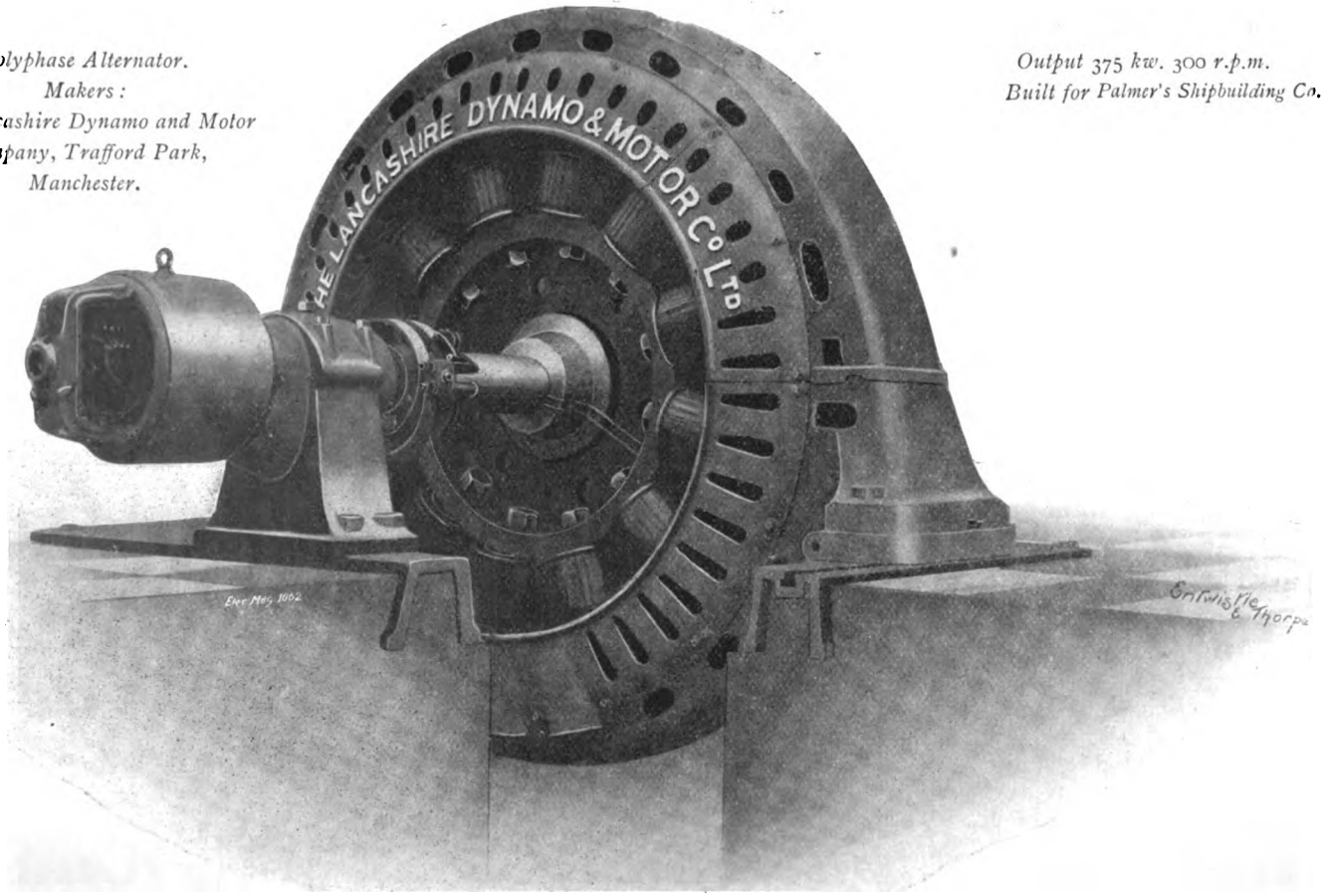
GIBBS' VENTILATORS ON THE "CARONIA."

a few of the ventilators fitted on the *Caronia*. We need hardly remind our readers that Messrs. John Gibbs and Son, of Duke Street, Liverpool, are ventilating experts and have a number of compact and efficient electric fans and blowers on the market.

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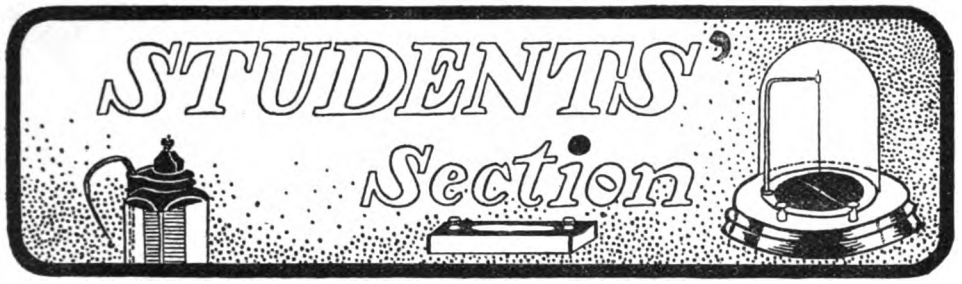
Polyphase Alternator.
Makers:
The Lancashire Dynamo and Motor Company, Trafford Park, Manchester.

Output 375 kw. 300 r.p.m.
Built for Palmer's Shipbuilding Co.



Standard Types of Electrical Apparatus. VII.

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Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

The Engineering Department of the Brighton Municipal School of Science and Technology.

By H. H. BROUGHTON.



THE growth of the Engineering Department since the opening of the School in 1898 has been so rapid as to render additional equipment absolutely necessary. The inauguration of the new department by Sir Wm. H. White, K.C.B., D.Sc., F.R.S., LL.D., took place on December 21, 1904. The department is divided into three sections—civil, mechanical, and electrical, and the courses of study laid down are intended to equip young fellows over sixteen years of age with such mental and practical training as will enable them to enter the works or offices of an engineering firm with advantage to themselves and to their employers.

The courses of study extend over three years, and include lectures, drawing-office practice, laboratory experiments and investigations, and practical work in the workshop. For the first two years there is very little difference between the time-tables of any class of student. The advantages attending a sound knowledge of mechanical engineering, no matter what the branch in which the student hopes ultimately to specialise, are so well known as to need no discussion. In the third year the courses differ widely, students spending most of their time in either the mechanical or electrical laboratories.

In addition to lecture rooms specially fitted for the work, but needing no detailed description, the department contains a mechanics' laboratory, a steam- and heat-engine laboratory, engineering workshops, boiler house, electrical engineering and testing laboratories, and metallurgical laboratory. Being so recently installed, the managers of the school have been able to put down plant of the most modern description by well-known English, Continental, and American makers. By so doing, students become conversant, not only with machines of home manufacture, but also with those from a foreign market, and the importance of this from an educational standpoint cannot be over-emphasised.

Mechanics' Laboratory.—The new mechanics' laboratory is equipped with apparatus for demonstrating the laws of mechanics and hydraulics, and for testing the properties of materials. A testing machine of the horizontal type by Messrs. Greenwood and Batley of Leeds, capable of exerting a force of fifty tons in either tension, compression, or bending, has been installed. The machine is supplied with the necessary instruments for making exact determinations of the properties of specimens under test. Apparatus has also been installed for experimenting on the flow of water in pipes, through channels, and over weirs. A 5-b.h.p., motor-driven, centrifugal pump will shortly be added to complete the equipment of the hydraulic laboratory.

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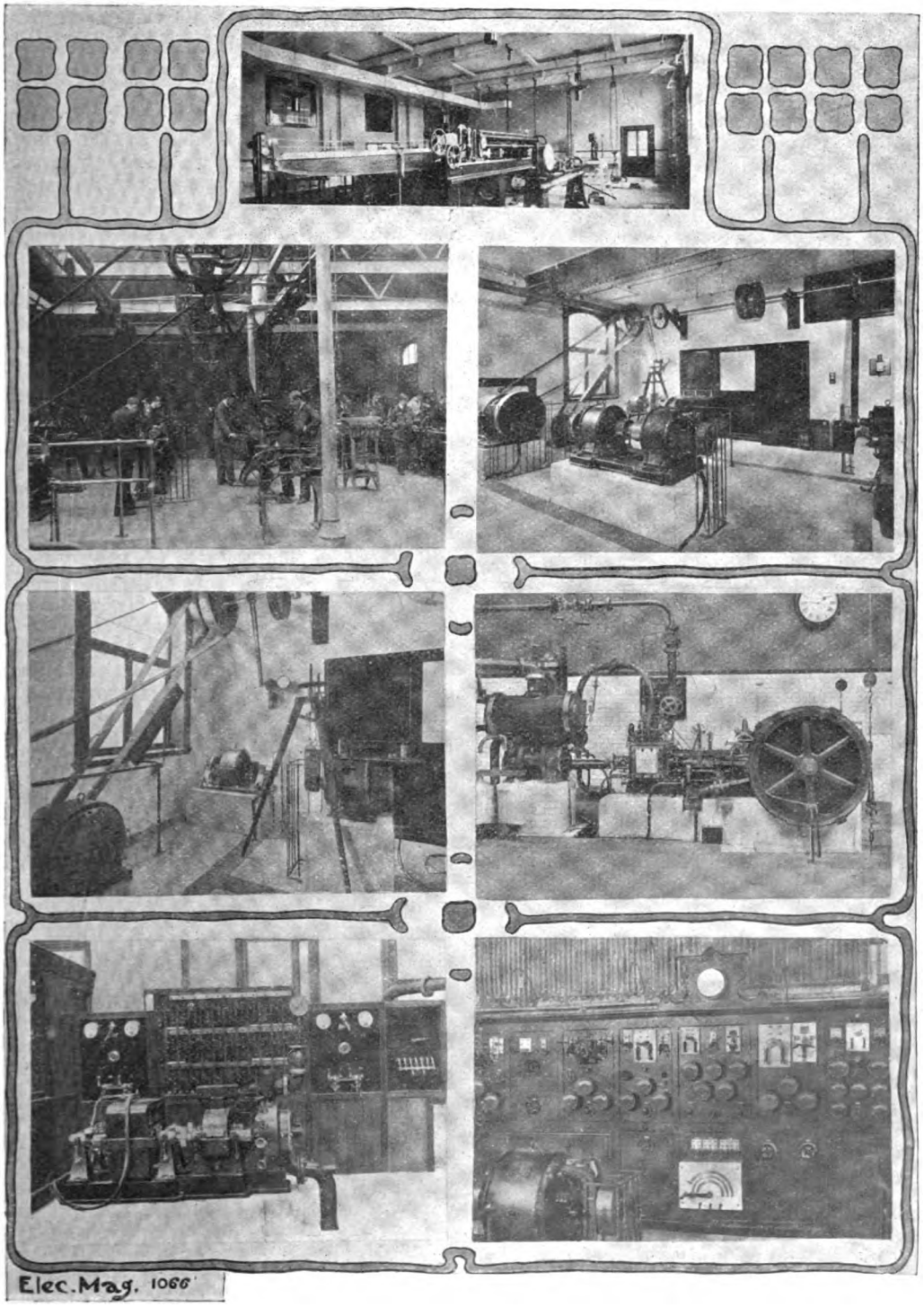
Engineering Workshop.—The engineering workshop, and steam- and heat-engine laboratory, are in a separate new building about 75 ft. long, and 45 ft. wide. The workshop contains benches for fourteen students, and is also well equipped with good examples of modern machine tools, driven by a 12-b.h.p. gas-engine, by Messrs. Tangye of Birmingham, with an alternative electric drive. There are several screw-cutting lathes, the largest, a 10 in. centre, by Messrs. Archdale of Birmingham. An example of an American lathe is afforded by the Hendey Norton Company, of Torringdon, U.S.A. The capstan-lathe, by Messrs. Alfred Herbert of Coventry, is semi-automatic in its action, and is specially designed for repetition work; many thousand thimbles, terminals, and insulating bushes, for the electrical department, being made, at a very low cost, by students working this machine last summer. The milling machine, by Messrs. Lister and Co. is fitted with the necessary attachments for gear cutting. Two planing machines, a shaping machine, a slotting machine, two drilling machines, several hand and smaller power lathes, and power hack-saw, complete the equipment of the metal workshop. The pattern-shop is situated in the basement of the school, and the three lathes, band, and circular saws are motor driven, current being supplied by the town at one penny per unit. The whole collection of tools enables students to acquire a knowledge of the ordinary operations of an engineering workshop: facility and skill in such operations is, however, only to be obtained by long practice under commercial conditions.

Steam- and Heat-Engine Laboratory.—This laboratory is equipped with both steam- and gas-engines specially arranged for experimental work, and with a turbo generator, which is used for lighting the building, but is also available for experimental work. The steam-engine is a 30-b.h.p. compound engine by Messrs. Marshall of Gainsborough. The engine can also be run as a simple engine, using either the high-pressure, or the low-pressure cylinder as desired. Both cylinders are jacketed, and are so arranged that the amount of water used can be easily measured. The engine is fitted with a surface condenser, the piping arrangement allowing the steam to be sent either to the condenser or direct to the chimney, as desired. The air pump is worked from the tail rod of the low-pressure cylinder, and can be uncoupled in a few minutes when it is desired to run non-condensing. Both cylinders are furnished with expansion valves; the one on the h.p. cylinder being operated by means of the governor, which is of the well-known Hartnoll type. In addition to the cut-off governor, the engine is provided with a throttling governor in order that the effects of the two methods of governing may be studied. The power developed by the engine is absorbed by two rope-brakes, placed on the fly-wheels, the rims being of special section and water-cooled. The quantities of feed water, condensing water, &c., are determined by means of graduated measuring tanks. The engine is provided with indicators, and with all the necessary thermometers, and pressure gauges for taking exact measurements of the power developed, steam and coal consumption, temperature and pressure of the steam, temperature and composition of the flue-gases, &c.

The laboratory is also provided with a Crossley gas-engine, of 22 b.h.p., specially arranged for testing. The power of the engine is absorbed by a rope brake working on a water-cooled brake pulley. Suitable indicating gear has been fixed, and thermometers fixed, so as to allow the temperature of the jacket-water to be taken. The gas supply is measured by means of a meter with special dial.

Lighting and Power. — For lighting, power, and experimental purposes a pair of 10 kilowatt, turbo-driven generators have been installed. The steam turbine of the De Laval type runs normally at 22,000 revolutions per minute, with a steam pressure of 150 lbs. per square inch, and may work either condensing or non-condensing. The rating is 30 b.h.p. The generators run at 2,200 revolutions per minute, the reduction being effected by double helical gear wheels, cut from the solid, the pinion and turbine spindles being made from a nickel steel forging. To control the turbine a highly sensitive governor, of the throttling type, is fitted; and by this, the speed variation,

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Engineering Workshop.
Corner of Dynamo Room.
Steam Turbo-Dynamo.

Mechanics' Laboratory.

Main View of Dynamo Room.
Steam Engine.
Switchboard in Dynamo Room.

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from no load to full load, is kept within the limits necessary for maintaining constant voltage at the generator terminals. The dynamos are shunt wound of the two-pole type with a common yoke, and at full load for six hours the rise of temperature, as measured by a thermometer, does not exceed 50° F. Each of the machines has a panel on the main lighting switchboard, the usual instruments and regulating resistances being fixed. The building is wired for the three-wire system of lighting at 230 volts, and under these conditions the machines are run in series, but for power purposes current for lighting the building is taken from the town mains, and the generators run in parallel. The changes from series to parallel, and for putting the lighting circuits on the town are effected by means of a seven-pole throw-over switch; four of the points being taken by the generators, and three for the town mains. The building is fed by eleven circuits, each of which is controlled by a treble-pole change-over switch. The system of distribution has recently been altered, all the main and sub-section fuses being located on a polished slate board, each fuse having a number corresponding to the number of the room protected by the fuse. From this board the various points are carried in screwed steel barrel to the vertical leads serving the several parts of the building. For testing purposes a water resistance is being put down to deal with the load, and arrangements are made for the whole of the students, mechanical and electrical, to conduct thorough scientific tests of this plant. It is also part of the course of the senior electrical students to take charge of the lighting of the building, by which means they gain useful experience in this branch of their work.

Boiler House.—Steam for the engine and turbine is generated in a Babcock and Wilcox water-tube boiler, situated in the basement of the school. The boiler is capable of generating about 1,300 lbs. of steam per hour, at 160 lbs. pressure. The tubes 4 in. diameter, and 12 ft. long are cleaned from soot by means of a steam jet, small doors being provided in the brickwork for introducing the nozzle. The temperature of the flue gases may be taken either by means of a nitrogen thermometer, or by an electrical pyrometer.

A small vertical boiler 3 ft. diameter, and 7 ft. high, working normally at 60 lbs. per square inch is installed for latent heat determinations, dryness, fraction, &c., and for working the Babcock boiler under forced draught, the exact amount of steam used being readily determined.

The Brighton water being hard, is softened in a large upper tank at the back of the engine. The water is heated by means of steam, and caustic soda introduced, the exact amount required having been found by experiment. After precipitation, and when the water is clear, it is run off into the tanks below, where it is ready for use. The whole of the feed-water on its way to the boiler passes through a feed heater, heated with exhaust steam from the engine.

Electrical Engineering Laboratory.—The laboratory, containing the various generators and motors, is situated in the basement of the School. The whole of the static experiments are carried out in one or other of the three laboratories attached to the Physics Department. The plant in the laboratory consists of the following:

One 22-b.h.p. motor by the Lancashire Dynamo and Motor Co., running normally at 730 revolutions per minute on 230 volts.

One 15-b.h.p. motor by Royce, running normally at 850 revolutions per minute on 460 volts.

One rotary converter, built by Messrs. Easton and Anderson, having an output of 5 kilowatts, fitted with six slip-rings, giving single-phase, two-phase, or three-phase currents.

Two dynamos by the Lancashire Dynamo and Motor Co., each of a maximum output of 6.5 kilowatts at 230 volts, direct coupled on a common bed-plate, each machine fitted with driving pulley and water-cooled brake; spare armatures for 115 volts being also provided.

One dynamo by the Electrical Construction Co., of a maximum output of 4 kilowatts, at 50 volts; with shunt and compound windings for characteristics.

One 2-kilowatt balancer set by the Westinghouse Co. for a three-wire 55-volt supply.

One rotating field alternator by Crompton, of a maximum output of 5 kilowatts, capable of generating one-phase, two-phase, or three-phase current.

One single-phase induction motor by

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Crompton, giving 3 b.h.p. at 230 volts on a 50 circuit.

The switchgear has been supplied by Messrs. Suter and Co., Ferranti, Ltd., British Thomson-Houston Co., and Blackwell and Co., and the instruments by Nalder Bros. and Thompson.

All the machines are permanently connected by conductors run in channels under the floor to the main switchboard, each machine having a complete set of switches, instruments, and regulating resistances, in order that all the equipment may be in use at one time. The board is fed from the 230-460 volt 'bus-bars connected to a three-pole throw-over switch, which in one position allows current to be taken from the town mains, and in the other from the turbo-generators. Each machine has points on a main distribution board, the connections of which are such that any machine can be readily coupled, by copper links, to either an iron wire resistance, capable of absorbing thirty kilowatts continuously without overheating; or a lamp-bank resistance of thirty kilowatts capacity; or a water-resistance of twenty-five kilowatts capacity. For three-phase work, the whole, or part of any of these resistances, can be arranged in a few moments for either star or mesh-connection to the alternators, and any of the machines may be loaded up, step by step, to 25 per cent. overload, ample protection being afforded by means of circuit breakers and fuses.

The majority of the machines have their mechanical output determined by Soames or rope brakes; the water-cooled brake wheels being fitted at the end of the shaft remote from the pulley. The two motors first referred to are arranged for driving the main shaft: either is large enough to deal with the load whilst the other is being tested. The normal speed of the shaft is 360 revolutions per minute, though by means of suitable regulating resistances in the motor circuits, about sixty speeds are possible, varying from 100 to 600 revolutions per minute; by this means, the various units may be tested at every conceivable speed.

The rotary converter is provided with main and shunt regulating resistances, together with two ammeters, a voltmeter, circuit breaker, main and field switches on the motor side, and ammeters and wattmeters in each of the phases on the generator side, the e.m.f. being measured by a hot-wire voltmeter with five-way switch.

The two dynamos by the Lancashire Dynamo and Motor Co. are of special design, enabling a wide range of tests to be carried out. Each machine has three sets of windings, the terminals of which are carried to points on the switchboard; by this means, the machines may be run as motors or generators with either separately excited, series, shunt, or compound fields, the excitation being controlled within wide limits by resistances in series, and in parallel with the field windings. Four methods of determining the efficiency are arranged, and the total losses occurring in the machines are analysed; each loss being found directly by experiment. Further, the machines may be run either as balancers for the school three-wire supply; or, as a motor generator, transforming direct current at 230 volts into direct current at 115 volts; or, as boosters. A series-parallel controller of special design with electric brake is installed to illustrate traction problems, and to complete the equipment, the set is about to be arranged for working as shunt motors on the auto-regenerative system of control.

The rotating-field alternator is provided with ammeters and wattmeters in each of the phases, and a common voltmeter with five-way switch. By means of a resistance in series with the field, the exciting current can be varied from 0.25 ampere to 6 amperes, and the speed may be adjusted so as to give any frequency from 25 to 100 cycles per second. Leads are taken from the machine terminals to the main distribution-board, and to four conductors running the entire length of the alternating-current laboratories. Voltage, current, and power curves can be obtained by means of an instantaneous contact maker and suitable instruments.

The single-phase induction motor is arranged so that the efficiency, torque, slip, power-factor, and brake-horse-power may be determined for ten different supply voltages from 50 to 300 volts and any speed from 750 to 3,000 revolutions per minute.

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In the alternating-current laboratories, there are, at present, installed five transformers, by various makers, ranging in size from 0.5 to 6 kilowatts, arranged for the various efficiency tests, and for carrying out these tests one common testing-table with a complete set of instruments is being designed.

To complete the equipment of the laboratories it is proposed to put down, shortly, the following plant :

One 2-b.h.p. Schuler single-phase motor.
One 3-b.h.p. single-phase commutator motor.
Three 1-b.h.p. single-phase motors by various makers.
One 8-kilowatt alternator with exciter directly coupled to a 12-b.h.p. shunt motor ; generating one-phase, two-phase, or three-phase currents at 2,200 volts (three-phase).
One 5-b.h.p. three-phase induction motor by English maker.
One 5 b.h.p. three-phase induction motor by Continental maker
Six transformers of English, Continental, and American design of 1.5 kilowatts, 3 kilowatts, and 5 kilowatts output.
One 5-kilowatt transformer with variable transformation ratio from 2 to 50.
One 25-b.h.p., 500 volt, traction motor.

Besides testing electrical machinery, students are expected to carry out commercial tests, mechanical, magnetic, and electric, on samples of iron and steel forgings, castings, and laminations, resistance material and insulating material ; exact determinations of current, voltage, and resistance being made by means of a Crompton potentiometer with the necessary adjuncts.

In the workshop adjoining the electrical engineering laboratory a course of cable-jointing is carried out, all the more usual sizes of cable up to 0.5 triple concentric being dealt with.

Electrical Testing Laboratories.— The equipment of the electrical laboratories attached to the Physics Department, consists of the usual apparatus necessary for the exact determination of the various electric and magnetic quantities entering into electrical problems, such as resistance, current, electro-motive force, flux-density, magnetising force, hysteresis, capacity, self and mutual induction. &c. The laboratories are supplied with current by overhead conductors led to a distribution-board with multiple 'bus-bars, from a battery of secondary cells ; variations of voltage being effected by plugging the various bars. Heavier currents of any voltage, up to 460 volts, are obtained by means of a rheostat in series with the town mains. The testing-room adjoining the general laboratory is equipped with a Kelvin quadrant electrometer, and D'Arsonval ballistic, and various forms of the reflecting galvanometer, the instruments being fixed on suitable brackets in such a way as to render the handling of them during an experiment unnecessary. A dark room, fitted with an optical bench and the usual set of standards, has been arranged for testing arc and incandescent lamps.

The work in these laboratories is arranged in conjunction with that of the electrical engineering laboratory, and the course of study is framed with the object of giving students a good understanding of the principles of the subject before entering into detailed consideration of the design, construction, working and applications of dynamo-electric machinery.

The writer has to thank Mr. E. D. Foster, M.Sc., for detailed information of the equipment of the mechanical engineering laboratories, as without his assistance this article would never have been written.

The reader will be able to form an idea of the thoroughness of the evening courses of study by taking a single example—that of the Electrical Engineering Department. Students have an hour's lecture, an hour at electrical exercises, and two hours' practical work per week. The fee for the whole course is but five shillings per session. The practical work is divided into three sections : wiring and jointing ; cable jointing ; and dynamo testing, each section being managed by highly skilled men. To further extend the usefulness of the department, the writer is arranging a series of six semi-popular lectures on heavy dynamo electric machinery and power transmission, to which all persons, whether students or not, are invited to attend, and the course will include all the most recent installations by well-known firms.

You are an Electrical Student? We want to hear from you as we can do you a service. Just a post card with your name and address. That's all.

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Problems on Distributing Networks.—III.

By ALFRED HAY. D.Sc., M.I.E.E.

(Continued from Vol. II., p. 608.)

IN the last article we explained how the difficulty of maintaining an approximately constant P.D. at all points of a distributing network could be solved by the use of two distinct classes of conductors—feeders and distributors—and how the cross-section of a feeder could be determined so as to satisfy the condition of maximum economy. We further pointed out that the condition of maximum economy could not always be fulfilled, as the choice of the cross-section of a feeder was further limited by (*a*) the permissible temperature rise and (*b*) the permissible drop along the feeder. We next propose to consider some of the problems which arise in connection with a distributing network.

Such a network consists of a system of conductors laid along the streets where there is a demand for current, and if there is a demand along every street of a given district, the plan of the mains would resemble that of the streets, and might in some cases be very complicated. We shall begin our study of distributing networks by considering the case of a

Distributor fed at both ends.

Such a distributor is shown in Fig. 8. (Dec. 1904) A and B being the feeding-points at which the distribution is supplied with current. Starting from the feeding-point A and proceeding towards B, we find that there is a gradual decrease in the P.D., until a certain point is reached at which the P.D. has a minimum value. Beyond this point, the P.D. again rises as we approach B, at which point it has the same value as at A.

If the load is a uniformly distributed one, it is evident at once that the point of minimum P.D. lies half-way between the feeding-points. But in the general case of an irregularly distributed load the position of this point cannot be immediately inferred. We now proceed to show how the position of the point of minimum P.D. and the drop of potential from either feeding-point may be determined—(*a*) algebraically, (*b*) graphically.

Algebraical Determination of Point of Lowest P.D. and Drop along a Distributor fed at both ends.

In Fig. 10 is given a load diagram for a distributor, F_1F_2, whose ends, F_1 and F_2, are supposed to be maintained at the

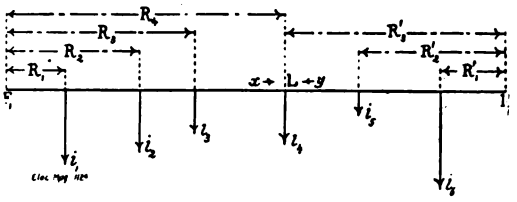


FIG. 10.

same P.D.* Let us arbitrarily assume any point, such as L, to be the point of lowest P.D. Then L will also be the point of lowest potential in the positive main, and the point of highest potential in the negative main. If we take F_1 F_2 to represent the positive main, then, L being the point of lowest potential, currents must flow towards it from both sections of the distributor, as shown. Let x be the current flowing towards L from F_1, and y that from F_2. It is evident that

$$x + y = i_4, \quad \ldots \quad (4)$$

which gives one relation connecting x and y. In order to find a second relation, we notice that, since F_1 and F_2 are supposed to be maintained at the same potential, the drop along F_1 L must equal that along F_2 L; in other words, the sum of the moments of the currents supplied by F_1 about F_1 must equal the sum of the moments of the currents supplied by F_2 about F_2. The point L must be regarded as the end of a distributor, F_1 L, fed at one end, F_1, only, and at the same time as the end of a distributor, F_2 L, fed at F_2 only. Considering F_1 L, the current which branches off at L must be taken as x, while in the case of F_2 L, the current leaving L must

* By the P.D. *at* F_1 is here meant, of course, the P.D. across the two mains, positive and negative, at this point. As has already been explained, only *one* main is indicated in the diagrams.

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be taken to be y. This being understood, we have

drop along $F_1 L = R_1 i_1 + R_2 i_2 + R_3 i_3 + R_4 x$
and drop along $F_2 L = R'_1 i_6 + R'_2 i_5 + R'_3 y$.

The two drops being equal, we have

$$R_4 x - R'_3 y = R'_1 i_6 + R'_2 i_5 - (R_1 i_1 + R_2 i_2 + R_3 i_3). \quad . \quad . \quad . \quad . \quad (5)$$

From (4) and (5) x and y may be easily found, and on substituting the value of x or y in the corresponding expression for the drop the value of the drop is determined.

We have supposed both x and y to be positive. The solution of the two equations (4) and (5) may, however, yield a negative value for one of them (they cannot both be negative, since their sum amounts to the positive quantity i_4). If x comes out negative, then this means that the current x, instead of flowing from F_1 *towards* L, flows in the opposite direction; hence L cannot be the point of lowest potential. The latter must obviously lie to the left of L, and since the numerical value of x is known, by following the distributor from L towards the left we can easily find the actual position of the point of lowest potential. Similar considerations apply to the case in which y comes out negative, the point of lowest potential now lying to the right of L. From this we see that even if our original guess regarding the position of the point of lowest potential were wrong, the solution of (4) and (5) would nevertheless immediately enable us to find its correct position along with the values of the currents flowing towards it, and hence also the drop.

In the practical application of this method it is, however, always possible to arrange the work so that the correct position of the point of lowest potential is immediately obtained. How this may be done will be best understood by a study of the numerical example given below, the load diagram for which is shown in Fig. 11. The distributor, which is 300 yards long, has a cross-sectional area of .125 sq. in., corresponding to a resistance of .000194 ohm per yard (of *single* main).

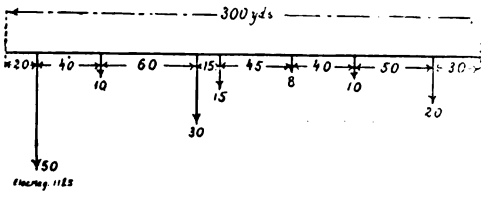


FIG. 11.

Referring to equation (5), we notice that each of the terms on both sides of the equation contains an R; now if l denote the length of any section of main, and r_0 its resistance per yard, then the total resistance R of that section is $r_0 l$. If we substitute this value in (5), then r_0 will occur as a common factor throughout the equation, and hence may be dropped. In forming (5), therefore, it is permissible (assuming, of course, a main of uniform cross-section) to use simple *distances* from the feeding-points instead of resistances, and this simplification we shall now adopt.

Starting from *each* of the feeding-points F_1 and F_2, we write down, in vertical columns, the values of the products l, i; and, in parallel columns, the sums of such products. In so doing, we proceed at such a rate from each feeding-point as to keep the two sums of products (corresponding to F_1 and F_2) as nearly equal as possible. This will be readily understood by an examination of the following tables, which show the various stages of the process:

Feeding-point F_1.		Feeding-point F_2.	
	Stage 1		
50 × 20 = 1000	1000	20 × 30 = 600	600
	Stage 2		
50 × 20 = 1000	1000	20 × 30 = 600	600
		10 × 80 = 800	1400
	Stage 3		
50 × 20 = 1000	1000	20 × 30 = 600	600
10 × 60 = 600	1600	10 × 80 = 800	1400
	Stage 4		
50 × 20 = 1000	1000	20 × 30 = 600	600
10 × 60 = 600	1600	10 × 80 = 800	1400
		8 × 120 = 960	2360
	Stage 5		
50 × 20 = 1000	1000	20 × 30 = 600	600
10 × 60 = 600	1600	10 × 80 = 800	1400
30 × 120 = 3600	5200	8 × 120 = 960	2360
	Stage 6		
50 × 20 = 1000	1000	20 × 30 = 600	600
10 × 60 = 600	1600	10 × 80 = 800	1400
30 × 120 = 3600	5200	8 × 120 = 960	2360
		15 × 165 = 2475	4835
		30 × 180 = 5400	7953

10,235

From the above it is evident that the

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point of lowest potential is that at which the current of 30 amperes branches off (corresponding to L in Fig. 10). The equations (4) and (5) now become

$$x + y = 30$$
$$1600 + 120x = 4335 + 180y.$$

Solving for x and y, we find $x = 27.78$, $y = 2.22$. Hence the drop along a single main from either F_1 or F_2 to L is $(1600 + 120 \times 27.78) \times .000194 = .957$ volt, and the total drop along the double main = 1.914 volt.

The currents in the various sections of the distributor are also easily determined. Starting from the point at which the current of 30 amperes is taken off, and which, as we have just found, is the point of lowest potential, and proceeding towards the left-hand feeding-point, we find for the currents in the consecutive sections of the left-hand portion of the distributor

$$x = 27.78\,;\ 27.78 + 10 = 37.78\,;$$
$$\text{and } 37.78 + 50 = 87.78.$$

The left-hand feeding-point therefore supplies 87.78 amperes. Taking next the right-hand portion of the distributor, and proceeding from the point of lowest potential to the right-hand feeding-point, we find for the currents in the consecutive sections :

$$y = 2.22\,;\ 2.22 + 15 = 17.22\,;$$
$$17.22 + 8 = 25.22\,;$$
$$25.22 + 10 = 35.22\,;$$
$$35.22 + 20 = 55.22.$$

This current distribution is shown in Fig. 12.

The maximum permissible drop along a

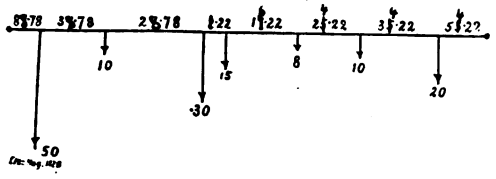


FIG. 12.

distributor is limited to 3 per cent. of the normal working voltage by the Board of Trade regulations regarding the supply of electrical energy. The 3 per cent. drop refers to the drop along the double main. Thus, with a 240-volt supply the maximum drop from any feeding-point to a point of lowest potential should not be allowed to exceed 7.2 volts.

From Professor to Student.

Electrostatic Voltmeters. — I required an instrument to read up to 200 volts, and not having one I connected two Kelvin electrostatic voltmeters—with maximum scale readings of 100 and 150 volts respectively—in series. Upon switching on I got a deflection of say 90 and 100 = 190. After opening the circuit and earthing, so as to discharge the instruments, I again switched on and obtained readings of say 40 and 150 = 190, the total being the same and correct, but upon leaving the circuit closed the reading of one of the voltmeters would fall to zero in a short time, whilst the needle of the other would go hard over. Could you tell me why this is? I think I can understand why the readings are different each time, but I cannot understand why, in a short time, one falls to zero and the other goes hard over. (F. C. Poulton.)

THE result you obtained is probably due to defective insulation and surface leakage. Assuming that one terminal of each voltmeter is connected to the frame of the instrument whilst the other terminal is insulated from the frame, it is obvious that if the insulated terminal of one be connected to the frame connected terminal of the other, there will be a marked tendency for the frames of the two instruments to be electrified to the same potential if the insulation of the supports of the instruments be poor or defective. In such a case the insulation of the supports will be soon broken down, which means that one instrument will be practically cut out of action, whilst the full circuit pressure will be approximately applied to the other instrument, the needle of which will go hard over. With perfect insulation the readings of the instruments should be the same each time.

PERCY NEWTON.—A very convenient form of Helmholtz's equation is as follows :

$$C' = \frac{E}{R}\left\{1 - E^{-\frac{R}{L}t}\right\}$$

in which C′ is the value of the current at the instant t after closing the circuit, R is the resistance, L the inductance of the circuit, and E (or 2.718) is the base of the Napierian system of logarithms. This equation expresses what Dr. Hay explains graphically in chap. iv. in his book, *Alternate-Current Working*. In exercise 2, chap. iv., t is the time required for the current of 200 amperes to fall to zero under the conditions given, and $2t$ is the time required for the reversal of the current to take place. To determine t substitute the given values in the above equation, thus :

$$200 = \frac{2}{5 \times 10 - 4}\left\{1 - 2.718^{-\frac{5 \times 10^{-4}}{10^{-5}} \times t}\right\}$$

$$\therefore\ 200 = \frac{2 \times 10^4}{5}\left\{1 - \frac{1}{2.718^{5 \times 10 \times t}}\right\}$$

$$\text{and } 1 = \frac{100}{5}\left\{1 - \frac{1}{2.718^{50t}}\right\}$$

$$\therefore\ \frac{20}{2.718^{50t}} = 19$$

$$\text{or } \frac{20}{19} = 2.718^{50t}$$

$$\therefore\ 50t \log 2.718 = \log \frac{20}{19}$$

$$\text{and } t = .001 \text{ second}$$
$$\therefore\ 2t = .002 \text{ second.}$$

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Exercises 3 and 4 of the same chapter may be solved graphically, but by applying the above equation and taking $C' = \frac{80\ E}{100\ R}$ the time may be found readily by calculation.

In the course of some experimental work I used an inverted rotary converter, transforming direct current at 220 volts into three-phase alternating current at about 130 volts, to drive a three-phase induction motor. There were three ammeters, one in each line, and it seems to me that their readings should have been identical. But I found that one of them always read the difference between the other two. Will you kindly point out the probable cause of this?

OUR correspondent does not state by how much the readings of the ammeters differed. If the difference was small, it may have been due to either inaccuracy in the instruments, or—assuming them to have been quite correct—to a want of symmetry in either the rotary converter or the motor. He is quite right in supposing that the readings—assuming symmetry—should have been the same. We would suggest to him: (1) to have the ammeters calibrated, or else checked against each other, *i.e.*, to see if they agree in their readings when connected in series with each other; (2) allowing the inverted rotary to run light (the induction motor having been switched off), to test it for symmetry by taking voltage readings across the three slip-rings in succession; (3) to take readings of the ammeters when the connections of the line wires to the induction motor are altered in cyclical order. If the ammeters are found to be correct, the differences must be due to want of symmetry. We may, however, mention that absolutely perfect symmetry cannot be expected to exist, and is in fact unattainable.

Could you inform me as to the best insulating oils for high-tension work, and add a few remarks as to their properties, mode of preparation, and chemical composition?

THE oil to be selected will depend on the particular use to which it is to be put. There are some characteristics, however, common to all good insulating oils. They must be free from acid impurities, and must possess a high flash-point, so that at the working temperature they do not give off any appreciable quantity of inflammable vapour; a lighted match thrown into the oil or the passage of an electric spark just above its surface should be quite incapable of igniting it. The oil used in connection with high-tension fuses is generally resin oil. It possesses the properties just mentioned. Chemically, it is a somewhat complex mixture of various organic substances, mainly hydrocarbons (*i.e.*, compounds of carbon and hydrogen). It is prepared by destructive distillation of common resin or colophony, and is that portion of the distillate which distils over between 300° and 400° C. For insulating transformers heavy mineral oils are commonly used. Such oils are prepared from crude petroleum by the process of "fractional distillation," which consists in introducing the crude petroleum into a suitable still, whose temperature is then carefully regulated, and kept constant within certain limits while the distillate is being collected. When no more distillate is given off the temperature is raised, and a new portion of distillate collected; and so on. The portion of the distillate suitable for purposes of insulation would have a boiling-point not below 250° C. The distillate is next refined, *i.e.*, freed from impurities, by treatment first with sulphuric acid, and then with caustic soda, these chemicals being afterwards carefully washed out. The heavy mineral oils of good quality used for engine lubrication are also suitable for insulating purposes. Chemically, they are a mixture of hydrocarbons of the paraffin series, having the general formula C_nH_{2n+2}.

A. Craven.

WE think it quite possible to do what you require, but as we have no data at hand as regards coils for high-pressure circuits it is scarcely possible to give a satisfactory answer as to cost and size of wire. The best plan will be to determine the particulars by experiments.

A Word on Literary Tone.

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Prime Movers in 1904.



THE central station engineer is essentially interested in prime movers, that is, as long as he wants to make use of them. When his network is supplied from huge carbon-cell units, prime movers may go whence they came, or somewhere else. As each year opens, so do the holes which contain the prophets, and last year was no exception to the rule as concerned prime movers. The steam-turbine was going to wipe the floor with everything standing up to it, and, as was expected, did not do anything of the sort.

The general outlook on prime movers reveals the steam-engine, reciprocating and turbine types, and the gas-engine, reciprocating and possibly turbine, as the chief aspirants for central station service. Reciprocating steam-engines are still made in large sizes, both here and on the Continent, while America has not been behind in this respect. The steam-turbine is, however, practically first favourite for the monster units now in common practice, and will evidently remain so. It must not be thought that it has such overwhelming advantages over its older rival, indeed on a thermo-dynamic basis the latter is superior in every way. The reciprocating-engine must, of course, be regarded as a perfected mechanism, and in comparing it with the turbine the limited experience of the latter must be taken into account. In the one case the end and aim of economy have been reached, or, at any rate, are in sight; in the other, unit sizes admitting of comparison have only recently been available for testing purposes. Consequently, the ultimate economy of the turbine is still a matter for some conjecture, while, on the contrary, the economic limits of the reciprocating-engine have been thrown into bold relief.

The gas-engine is still marking time, both in the reciprocating and turbine types. High-speed reciprocating sets of small output are now becoming common, but as a mechanism the gas-engine is far from perfect. In this respect it is eclipsed by its steam prototypes, and at present apparently nothing short of a revolution in design can bring it seriously into the competitive arena with its rivals. In Great Britain the gas-engine has had a run of bad luck, from which it is only now recovering. Several plants of fair output have got to work and appear to give every satisfaction, but the year brings records of one station throwing up the gas-engine for steam. Manufacturers are enterprising enough, and with the big engines having long German names may make headway, but it does not look as if it will be in this country, at any rate not yet. The steam-stations can feel quite comfortable on that score. Until the gas-engine is put forward in turbine form it would appear to have little chance of capturing the central station field from the steam-turbine. If many more years elapse before it is in

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fighting order, the turbine will have become common practice and the maker of slow-speed gas-engines will have to look round for the electrical engineer to build him a 5,000-kw. generator to run at 95 revolutions.

As to tests of the steam-turbine, central station engineers, that is, power-house superintendents, would do a service by conducting economy trials themselves independently of the makers, after the machines have been running a time. Data supplied from the man in charge is always more convincing, at least to others in the craft, and there are many plants from which matter of this kind would find welcome recognition.

Notes on the Working of Central Station Plant. VII.

By F. H. CORSON.

(Concluded from page 627.)

On the Keeping of Station Records.

HAVING touched on the more important points in the actual working of station plant, it will be probably worth while, in this last article, to devote some consideration to the keeping of the station records which should be a summary of the running of the plant and of the work done on it and by it.

Judged by this standard the entries in the usual station log-book are somewhat unfortunate. The number of apparently useless data which are religiously noted down, and when the book is filled, carefully put away to be rarely, if ever, referred to, would suggest that the aim of the engineer has been to provide light employment for the switchboard attendants rather than to keep a register which shall be immediately and always useful. How many station log-books so assiduously compiled are capable of giving at a glance, and with reasonable accuracy, even the most important details when considered from the commercial aspect ?

As examples of such data, let us say, the total number of units delivered to the mains, or used on the works ; the amount of coal and water used per shift or per day ; the number of hours run by each engine and boiler, and the current put into and taken from the battery if such is installed. In place of these most desirable records, we find the time and space occupied by the entry of particulars which can be made more easily and accurately registered by recording instruments. Every station engineer knows to what a large extent the faculty of approximation bulks in the mental equipment of the average switchboard attendant, enabling him to enter at least half a dozen quarter-hourly readings of load, voltage, &c., simultaneously, and the writer has known the readings of a whole shift to be logged during the last half-hour of it. That this can be done with impunity is a testimony to the comparative uselessness of the records. Again, where the advisability of metering the energy is admitted, considerable difference of opinion prevails as to the method to be employed, and meters are frequently placed in the most useless positions. It is not unusual to find every generator, large or small, provided with a meter while lamps and motors in most constant use in the works are neglected. The result is that while the energy generated *may* be known with some degree of accuracy, the information gained is of comparatively little value, as the more important data as to works consumption and net output to mains are indeterminate.

Given the time for such investigations it may certainly be interesting, if not very useful, to know how much work each unit of the plant has performed, but it is surely in a much higher degree desirable to know fairly exactly how much of this energy is absorbed by the plant as a whole, and how much may be regarded as available for sale. On the other hand it is to be regretted that of stations where the arrangement of the meters leaves little to be desired, it is only in comparatively few that these are constantly and consistently checked for accuracy, the general practice being to accept the readings as correct. The necessity for this frequent checking, will be at once obvious to any one who has tried to keep two or three meters, fixed in series in an engine-room, in agreement say within 2 per cent. of each other, and the writer considers that while the station engineer will, of course, endeavour to inculcate in the minds of his consumers, strong belief in the infallibility of electricity meters, he should regard his own with a considerable degree of watchfulness.

Until a meter is produced which shall be unaffected by stray fields and heavy vibration, the generating station will always impose difficulties in the way of accuracy. Considering this it is evident that better results are obtainable by the use of a few large meters which can be often tested than from the addition of the readings of a number of smaller ones

The checking of these meters ought to present no great difficulty, and the speed could, in most cases, be obtained at two or three definite loads, so as to give points

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from which the curve of the meter could be easily deduced. If it should be difficult to test the meters on load, the capital cost of a small battery of two or three large capacity cells which could be charged in series and discharged in parallel and a milli-voltmeter calibrated on two or three shunts of various sizes, to read amperes correctly, is not high in view of the value of the accurate knowledge acquired. Assuming then that the meters are correctly fixed and carefully checked from time to time, the next consideration is the use of the figures obtained from them, a matter which seems to provide scope for some difference of opinion.

With regard to the analysis of the costs of generation per unit, might one enter a protest against the intricate mathematical calculations frequently resorted to? The use of the third place of decimals in estimating the cost in pence per unit is fairly obviously unnecessary. A still more evident misapplication of energy was exhibited in an Annual Report recently published, in which the engineer after quoting the costs per unit of some other undertakings, set forth those of his own station in heavy type to the fourth decimal place. Surely the heavy type at least might have been spared? The figures must have been obtained from meter readings or worse still from log-book records, accuracy within 2 per cent. being difficult to guarantee in the former case and impossible in the latter, thus making the second place of decimals a doubtful quantity.

It is at least curious that an engineer who would never expect his weighbridge to measure his coal to within 1 per cent., nor his water meter to give equally correct readings, should fall into such an error.

Starting from data which are only approximately true, it is evident that a higher degree of accuracy in the conclusion cannot be confidently expected, and it is not too much to say that the data on which the estimates are based are often unreliable within 5 per cent. The time spent in elaborating these calculations could more profitably be devoted to checking such measuring instruments as are in use so as to be constantly assured that they are, within reasonable limits, correct.

Again the records, if any, which are kept of the date and nature of the repairs done to various sections of the plant are frequently hopelessly crude or else unnecessarily minutely subdivided.

On the one hand the repairs to boilers, buildings, and the electrical and mechanical parts of the generating plant cannot be separated, while, on the other the division is needlessly elaborated implying a large amount of clerical work and supervision and giving details of work, the knowledge of which is rarely of importance.

Bearing these considerations in mind, and with the object of usefulness and accuracy strictly in view, it will be seen that the station records will take a very different form from what is usually found. Readings of voltage, steam pressure, and vacuum &c., will be much more safely and satisfactorily left to the recording instrument and the particulars to be logged will be those which are not amenable to this treatment. Coal and water used on the boilers and oil used on the engines will be entered up along with the units generated and consumed in the works for each shift of the day. The material used will be divided by the units turned out of the station, any large variations in the results obtained being at once noticeable. In this way irregularities can be immediately checked and the effect on the economy of the works of running under various conditions can be easily investigated.

On such lines as these the station log-book will be converted from a heterogeneous collection of more or less useless and unreliable data into an eminently useful reference book. The switchboard attendant will be brought into closer touch with the actual working of the station and, stimulated by the knowledge that his work is directly of use, he will find greater interest in it and apply to it more energy. In these, as in all other records, the primary as well as the final consideration should be utility, and, only in proportion as the clerical work performed yields a direct return for the labour expended upon it, should it be done. It is not always remembered that the function of a generating station is to develop electrical power to be sold at the cheapest possible rate, and not to provide interesting scientific data which, in some cases, have little beyond their scientific interest to make them worthy of note.

When the strong commercial instinct is made the basis of the methods employed in running central stations and the works are no longer regarded as a laboratory to provide interesting experiments or as a training-ground for young engineers, we shall hear less of the lament of the underpaid assistant and less of the man who is too good an engineer to be a good business man.

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The Value of Latitude in the Manipulation of Machinery.

By A. M. VENTURER.

THE design of machinery has largely been governed by considerations of cost, reliability, and efficiency—generally in the order named. It is open to doubt whether the prime importance of so constructing a machine or collection of machinery as to give latitude in manipulation has been sufficiently recognised. At most, it has been regarded as an incidental advantage, only to be aimed at after the former conditions have been satisfied. Yet the direct money value of this property — mobility of operation—is so great that its importance is almost too plain to be insisted upon. Any plant which calls for a high degree of any virtue—watchfulness, accuracy, dexterity—is placed at a disadvantage by the fact that mankind is naturally not virtuous. The operator is either slothful, slovenly, slow; or else he wants to be highly paid for avoiding these defects. And such is the state of our engineering industry, even after so many years of technical education and practical training of assistants, that employers of labour are forced either to pay high wages or to buy plant that can be handled with the least possible degree of care.

Cases in which this mobility of operation has proved of unexpected value are not difficult to find. Take for example the parallel running of alternators. The chief reason, apart from mechanical strength, that the iron-cored alternator with its comparatively heavy lag superseded the air-core machine, is that when machines of the former type are in parallel their heavy impedance chokes back disturbing cross-currents due to unequal turning-moments, requiring less rigid governing and permitting a larger angular variation per cycle of their fly-wheels to be allowed in the design. But a third advantage was speedily discovered—synchronising had to a large extent lost its terrors. If a bad phase were taken, the coils would neither burn up nor rack to pieces; the lights might drop, but in every probability the machines would pull into step. This, in practice, is one of the great advantages of the iron-cored machine. Again, the air-core type of machine had, owing to the low armature-inductance, a very pointed curve connecting the armature currents and field excitations for a particular load. That is to say, at every load there was a particular excitation at which the current, and hence heating of the windings, was a minimum. Slight divergences on either side of this field value produced large augmentation of useless current. In iron-cored machines the curve is much flatter, a wider variation in excitation producing much less current-waste; in other words, the machine resists the effects of carelessness on the part of the attendant much better, and is therefore a more useful machine for general purposes.

The same argument may be applied to the increasing use of asynchronous in place of synchronous motors in poly-phase power-transmission. The former require a simple switching in and out, with perhaps the manipulation of a rotor resistance, while the latter have to be synchronised. Hence, in spite of the large wattless current of the induction machine, and its variability of speed under load, it is coming more and more into favour because it requires less precision in operation. Or take the case of a direct-current dynamo or motor. A fixed load or lag of the brushes is becoming recognised as a most desirable point in the design, because attendants are unable or unwilling to devote the necessary amount of care to rocker-regulation. The condition was, of course, first rendered imperative in traction work, where heavy sudden variations of load were thrown on the generators and motors. The requirement is, however, extending to machines for all varieties of work, simply because the value of latitude in operation is gradually becoming recognised.

Such latitude is, however, often sacrificed to so-called efficiency or economy. For example, there are lamps on the market that would work at a marvellously low consumption per candle power and maintain the performance throughout a respectably long life, if the voltage of supply were absolutely constant. But any one familiar with supply undertakings will know that invariability of pressure is not practicable. Apart from

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drop in mains, there are such station disturbances as speed variation of generators, lapses of attention, and mistakes on the part of switchmen and drivers. The remedy is not to insist on the perfect working of the plant, which is impossible, but to design every part of the apparatus with a safe latitude-factor.

Possibly there is no place where the need for latitude is so keenly felt as in a power-generating station. The instances that could be cited are almost numberless. The very simplest case is the value of spare plant. Practical experience shows that a spare generator set, a spare boiler, should always be ready to give mobility of working in case of breakdown. In the stores are kept those spare parts which are thought most likely to be necessary in emergency. Yet in spite of this, modern design is tending in the direction of the abolition of latitude. Station designers have been impressed with the increased economy obtained by massing the available power into two or three large units. It must not be forgotten, however, that the mobility of the station in the event of the breakdown of one unit is diminished the larger the proportion of each unit's capacity to the total load. Sub-division in this case means flexibility of manipulation. We note the supersession of the old ring system of steam mains, with its alternative methods of operation, by the "detached units" arrangement—a boiler, engine and dynamo perpetually linked together with no intercommunication between the sets. Water-tube boilers, which on account of their quick-steaming properties are now much more largely used than the older Lancashire type, give much less latitude in stoking owing to the unsteadiness of their steam. In the Lancashire boiler the intervals of firing may be longer and more erratic without result to the steam-pressure, a lower-class and yet less-supervised stoker being permissible. Where the daily load on a station is fairly constant, or where its increase or decrease is to a fair extent foreknown, a return to the Lancashire type appears highly desirable.

The modern craze for cheapness, both in construction and running, is carrying us a long way in the direction of limitation of flexibility of operation. The design of plant in central stations should be amply large for all conditions of hurried manipulation. A condenser plant should be able to produce a vacuum when started either before or after the engine is running on load; the engine should be able to do a respectable amount of load without its condenser, if necessary. We must nowadays guard against too much automaticity. Automatic machinery is good so long as it is in working order. But such plant is by its construction more or less inflexible in its action. It is more difficult, for instance, to force an automatically-stoked boiler fire than one stoked manually. Moreover, if the automatic gear breaks down at any point, it not only entails a sudden demand for extra manual labour, but is often so arranged that by no possibility can hand labour be employed till the automatic machinery is unshipped. The hand-firing doors provided on some of the automatic stokers on the market, owing to doubtless excellent considerations of the disposition of available space, give one a most depressing idea of the effect of a breakdown of the gear on a peak load. Latitude of operation is emphatically not theirs.

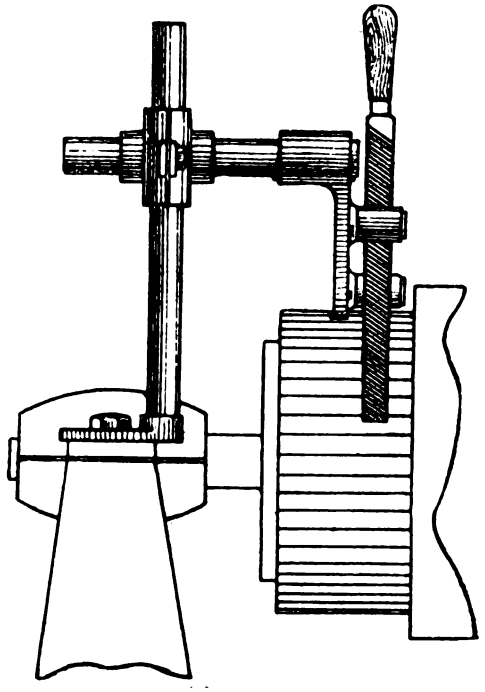
It is well, therefore, to insist as strongly as possible on the necessity for flexibility in the working of plant. Economy may be slightly reduced, initial cost may be greater, but the safety of operation, the absence of expensive breakdown, and the possibility of keeping the operators free from that nervous worry which often precipitates a catastrophe, will render the value of latitude in the operation of machinery very apparent.

FILING DEVICE FOR COMMUTATORS.

THE Excelsior Machine Works, Akron, Ohio, is manufacturing a filing device for the truing of commutators. This is shown in the accompanying illustration. The principal part of the machine is a standard, provided with a foot, by which it can be attached to the bearing of the motor or generator. This standard carries a horizontal bar, which may be clamped at any desired height. The bar carries a file-holder, which may be moved across the face of the commutator. The cutting tool is an ordinary file, held in the proper position

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by means of the file-holder. The file rests on two pins, one of which is slotted and so located as to steady the file without the possibility of chattering. The file, as it is moved back and forth over the com-



FILING DEVICE FOR TRUING COMMUTATORS.

mutator, cuts to a uniform depth, thus levelling the surface lengthwise and restoring the true cylindrical form. The commutator may be readily smoothed off as soon as the surface begins to show any signs of wear, and before it has become uneven enough to warrant the removal of the armature or the amount of metal that would ordinarily be taken off by means of a cutting tool.

NOTES.

Behaviour of Insulators with High Tension Continuous and Alternating Currents.

IN a recent issue of *Elektrotechnischer Anzeiger*, A. Gradenwitz records the experiments made by the Compagnie de l'Industrie Electrique, of Geneva, Switzerland, on the behaviour of insulators in regard to high tension alternating and continuous currents. Alternating current of fifty periods and very flat current curves was used, while three Thury dynamos of 25,000 volts and one ampere each, being mounted in series, served to produce the continuous current. The results of these trials are highly in favour of continuous current, it being shown that insulators will stand the highest tensions far better in the case of continuous current than in that of alternating current. Odinary glass 0.3 mm. in thickness was found to withstand a tension of 25,000 volts, while a disc of plate-glass stood a tension of 50,000 volts, and ordinary telegraphic insulators as much as 65,000 volts, with continuous current. By a prolonged exposure to rain, the limiting tensions were reduced to some extent, becoming, however, only 1.63 times smaller than in the laboratory.

Tests on the Nernst Lamp.

THE authorities at Hamburg have carried out some tests for themselves on the Nernst lamp, and the results are given in the appended table. It may be said that the lamps have a horizontal filament stretched below a flat zigzag heater, and that the series resistances absorbed fifteen volts. The lamps were turned out twice a day

Table of Results.

No. of lamps.	Hours of burning.	Mean pressure at the lamps in volts.	Consumption in watts.	Candle-power in direction of the axis. (Hefner units.)	Consumption per Hefner c.p.	
10	0	111.0	30.7	19.7	1.6	Pattern B, 0.25 a., 110 v.
10	25	109.3	29.8	14.4	2.1	
10	50	110.1	30.5	12.3	2.5	
10	75	109.9	30.0	12.4	2.4	
10	100	109.6	29.5	12.6	2.3	
10	200	103.9	29.5	12.2	2.4	
10	300	103.9	27.8	12.3	2.3	
10	400	110.0	26.7	9.4	2.8	
10	500	112.0	27.1	10.5	2.6	
10	600	110.1	22.3	7.0	3.2	
10	700	110.4	21.5	6.2	3.5	
10	0	110.5	57.4	44.4	1.3	Pattern B, 0.50 a., 110 v.
10	25	112.0	57.4	29.7	1.9	
10	50	109.3	55.8	28.7	1.9	
10	75	110.3	55.5	26.5	2.1	
10	100	109.5	55.5	27.7	2.0	
10	200	109.1	54.6	27.9	2.0	
10	300	109.4	53.4	24.0	2.2	
9	400	110.4	53.7	23.6	2.3	
9	500	111.1	53.1	24.1	2.2	
7	600	111.4	49.3	19.6	2.5	
6	700	110.2	42.7	14.4	3.0	

in order to approximate to working conditions, and it will be seen that even after 700 hours the efficiency was about the same as that of a new incandescent lamp.

We want Central Station Engineers to contribute to this Section.

It makes no difference if you are in the Station or on the Mains, we shall be pleased to publish and pay for your views.

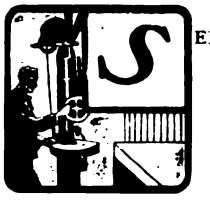
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Electrical artisans should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles on subjects of importance to themselves.

Modern Milling Practice.

By W. D.



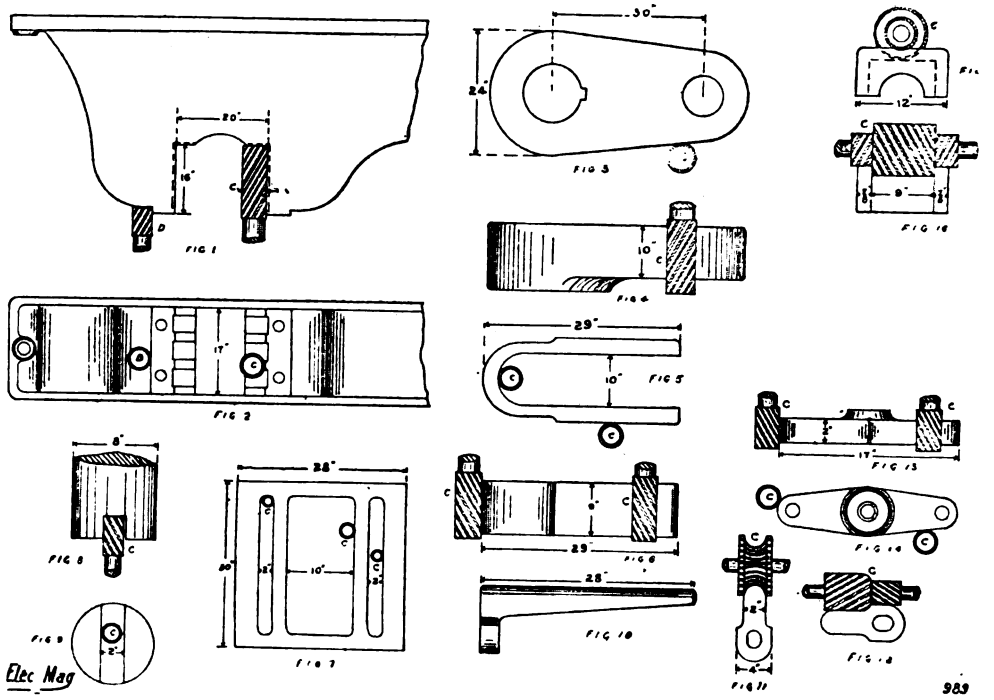
SEEING that the milling machine has taken such an important part in increasing the output of the modern machine shop during the last few years, a few examples of up-to-date practice, as carried out by some of our leading English builders of heavy slow-speed engines, may be of interest to the majority of readers. In almost every case millers affect a considerable saving of time and money, compared with the older methods, and without any special appliances being needed beyond the regular cutters which can be used on a variety of work.

Fig. 1 shows in elevation the pedestal end of a large Corliss engine trunk bed. The main crank shaft bearing is of the adjustable type, and the chipping strips down each side, and across the bottom for a distance of 4½ in. on each side, require to be accurately machined, as also does the top surface for the pedestal cap. This operation was formerly a very slow process and usually a lot of hand chipping had to be done. It is now done on a large miller of the horizontal spindle type with a great saving of time and labour. The bed is bolted up against two large angle plates cramped on the floor plate, and a large cutter C, 18 in. long and 7 in. diameter operates on each side and across the bottom by the vertical feed. This makes a very satisfactory job at a cutting speed of 30 ft. per minute, with a cut $\frac{5}{16}$ in. deep and a feed of 1⅞ in. for roughing, whilst for finishing the speed is increased to 45 ft. with a feed of 2½ in. with a cut $\frac{1}{16}$ in. deep. The short stiff cutter D is 6½ in. diameter and 8 in. long, and is used for milling across the top, and along the edges for the cap as shown, the vertical feed also being used for this operation. Fig. 2 shows the same job in plan.

Fig. 3 shows the plan and Fig. 4 the elevation of a large forged steel crank. This is machined to shape round the edges, as shown, on a large vertical spindle slab miller or plano-miller, the straight sides being done first, the two ends then being finished on the circular milling attachment mounted on the table. The cutter C is 16 in. long and 7½ in. diameter, and with a roughing cut ¾ in. deep and a feed of 1¼ in. running at 35 ft. per minute, with a good supply of lubricant for cooling the cutter. For finishing the speed is increased up to 50 ft. per minute, with a feed of 2¼ in. per minute and a cut $\frac{1}{16}$ in. deep. These cranks when slotted took a fitter twenty-one hours each to file up and polish. The milling cutter with lubricant leaves a fine finish and the job now takes eight hours each, only to polish up.

Figs. 5 and 6 show the plan and elevation of a large steel strap for the connecting rod. This is machined all round both inside and outside on the vertical spindle miller. The cutter is shown at C and runs at a peripheral speed of 35 ft. per minute, and a feed of 1¼ in. per minute for roughing. When finishing the speed is increased up to 50 ft. per

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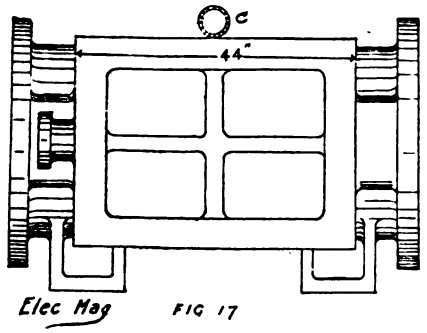
minute with a feed of 2 in. per minute. These straps formerly took twenty-five hours each to slot, but we now mill them in sixteen hours each, and also save a large amount of time in filing up and polishing, the milling cutter leaving a much smoother surface than the slotting tool.

Fig. 7 shows the plan of a large slide-valve arranged for cut-off valves to work on the back face. On this the edges of the steam and exhaust ports require to be straight, and we used to slot and chip round the ends, taking about twenty-five hours each to complete the two faces, back and front. We now make a more satisfactory job of them, by milling on a verticle spindle milling machine with a cutter 1½ in. diameter, running at a peripheral speed of 26 ft. per minute, with a feed of 1¼ in. depth of cut ⅛ in. Once round is sufficient to make a smooth surface, and the time taken to complete one valve was nine hours without any chipping.

Fig. 8 shows the plan and Fig. 9 the end view of a Corliss valve, front end cored for the spindle. These formerly took 4¾ hours each on the slotting machine, but we can now mill them on a horizontal spindle miller, using the vertical feed with the end and side milling cutter shown at C. They are now completed in 1¼ hours each, the slot being parallel and requiring no filing.

Figs. 10, 11, and 12 show a large cotter, forged steel, for the strap end of a large connecting rod, machined all over in a Lincoln pattern milling machine by cheap labour. Fig 12 shows the two cutters, C, "ganged" for milling the sides including the lug and radius at the end. Fig. 11 shows the concave cutter, C, milling the convex edge of the cotter, the opposite flat edge being milled to the requisite taper by an ordinary flat cutter, and the large convex end by a concave cutter of the same radius. These were formerly done on planing and shaping machines, and were a very unsatisfactory job—a large amount of hand chipping and filing having to be done round the large end. A boy can now do one complete in 5¼ hours, the formed milling cutters making a first-class job, and leaving no filing or chipping to be done except taking the sharp edges off. This is a good example and effects a saving of 80 per cent. in wages, as well as being a more satisfactory job.

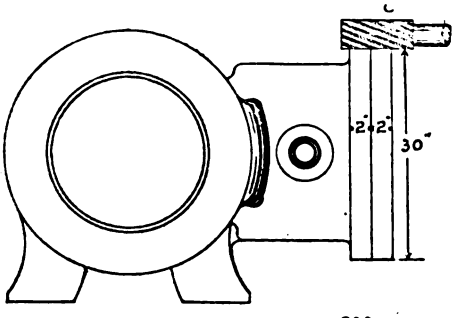
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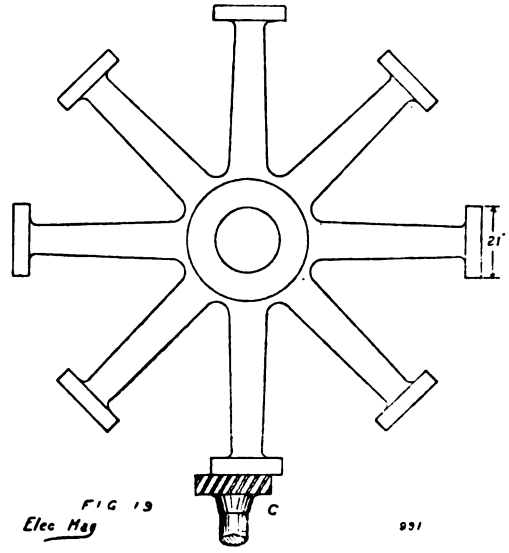
Figs. 13 and 14 show the elevation and plan of a forged steel cross-bar for a stop valve machined all round. When slotted these took nine hours each, but we now mill them on a vertical spindle miller in two hours each, and put a good finish on them. The straight sides are done first, the ends being done afterwards by the circular motion. The cutter is shown at C and runs at 45 ft. per minute with a feed of $1\frac{1}{4}$ in.

Figs. 15 and 16 show the end and side elevation of a large brass step for a connecting rod end. These we mill to size by "ganging" the cutters as shown at C, thus making them the correct width for the strap without much filing; peripheral speed of large cutter 80 ft. per minute with a feed of $2\frac{1}{2}$ in.

Fig. 17 shows the side elevation and Fig. 18 the end elevation of a steam cylinder and valve chest. C shows the cutter milling on the top edge of the steam chest flange and cover, the horizontal feed being used for the top and bottom, and the vertical feed for the ends: peripheral speed of cutter 35 ft., feed 2 in. per minute, with a cut $\frac{1}{8}$ in.



deep, diameter of cutter 6 in. These we do at once round, and make a good smooth surface, which does not require much filing up and polishing. Fig. 19 shows the spider of a large fly-wheel 18 ft. diameter cast solid, the arm ends require to be machined, to bolt the rim to. This we do on a large horizontal spindle milling machine, the bore of the wheel fitting on a boss bolted to a large floor plate fixed in front of the machine. Each arm is brought before the cutter in turn to be milled; the cutter C is 22 in. diameter and of the inserted tooth type having a cast-iron body, the teeth or cutters being made out of "Capital" brand high-speed steel, $\frac{3}{4}$ in. diameter, round, given a forward rake of ten degrees,



peripheral speed of cutter 55 ft. per minute, feed $1\frac{1}{2}$ in., depth of cut $\frac{3}{8}$ in. This would be a difficult job to do on any other machine, but it is successfully accomplished in thirty-one hours on this miller.

Workmen need not be afraid to write on any job coming under their notice, and of interest to their fellows. We pay good rates.

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WIREMEN'S SECTION.

Looking Round.

ARE we now on the verge of better times? There can be no doubt that the state of the electrical trade has taken an upward tendency, and the question that naturally arises to the worker is, Will the improved conditions continue, or is it merely a temporary improvement with the usual aftermath of lack of employment? The general indications point to that slow and steady increase that leads to prosperity. This is pleasant to contemplate after the long spell of bad trade that we have been through.

There is a volume of commendation for our employers that, notwithstanding the many fresh fields opened up of late, the disastrous effects of a boom—as witness the cycle trade—have been carefully avoided. Long hours and high pay soon come to an end, and the result is well illustrated by the large number of cycle fitters, &c., who are still out of work.

A glance down a list of the various power schemes in hand and projected gives every reason to hope for a busy time in the electrical trade for some considerable period. A large portion of the contracts are bound to go abroad, just as English firms secure contracts from foreign countries. Whether affairs balance themselves is, of course, a vexed question, and one that is too much before the public to refer to here.

We have enough of bad trade, with its effect upon the workers, and those whose misfortune it has been to lack employment will welcome the brighter aspect the more readily. There is in the labour market that continuous swing of the pendulum which produces depression at more or less regular intervals.

Taking the engineering trade throughout the country, the average of unemployed at the end of December last was 11.2 per cent. For January of this year this figure had improved to 8.1 per cent. The February figures are better still, and we have every reason to hope for the normal figure of 5 per cent. The figures for the previous December (1903) were 8.5 per cent., and things got gradually worse for the whole of the year. When looking at these figures it is well to bear in mind that some of us are, at the best of times, out of work. The point is, how long do we remain out. When things are brisk, berths are easily found, but as far as statistics are concerned the harm is done if "out of work pay" is drawn. The trade unions are, to a large extent, the only means of getting at the state of trade, and a call upon their funds often shows up far more than it really means.

Whether fiscal alterations are going to provide us with more work is an open question, and it behoves us to struggle for our own interest. A vital point in the maintenance of supremacy for our products is the quality of the work turned out. There are, unfortunately, not a few men who give neither thought nor study to their work, and such hands, by causing defects in workmanship, are liable, when taken in numbers, to divert orders into other channels.

One day—let us hope in the near future—at least two reforms will be introduced into electrical workshops, &c., which will not only tend to produce better material and machinery, but give to the artisan some encouragement to strain every effort in the interest of his employer in particular and the trade in general. First, a system of registration ensuring the capability of the workman—effectually holding down the low-priced hand and shoddy work; and, secondly, some different method of reckoning wages. There are many schemes beyond the range of practice, but some project for paying a man for the actual amount of work produced as against time worked would be of great benefit to the skilled electrician.

Some Hints on Conduit Work.

PRACTICE has proved that in fireproof structures, iron-pipe conduit can be used where it is impossible to run cleats, porcelain, or even bare wires. By way of illustration, the writer has in mind a newspaper office in New York. The building had been used as a sub-station for a street railway company, and when vacated by the railway company was remodelled into an office building. Naturally, the building was of fireproof construction, with terra-cotta floors and wrought-iron frame-work. To make a finished ceiling, *wire* lath was installed and covered with plaster.

For the lighting system, main feeders were run from the main switchbox in the cellar to a switchbox located on the east wall of the ground floor of the building, entering the same from the bottom. The different lighting circuits were run from this distributing-board in ½-in. iron-pipe conduit, six to twelve lights being carried on a single circuit. The

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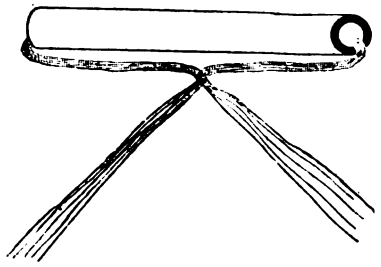


FIG. 1.

points requiring lights were in the centre of arches, so that girders or I beams were not available.

A primitive method of securing conduit to a wire-lath ceiling is illustrated in Fig. 1. A small ¼-in. nipple, 3 in. long, has several fine copper wires run through its bore, and these are twisted together at the centre. A small hole is cut in the ceiling, and the nipple is driven in upright past the lath. A sharp pull downward serves to adjust the device, and two men hold the conduit while a third draws the loose ends around the pipe and fastens them at the bottom by twisting. To obviate this makeshift and at the same time provide a more permanent device, a little adjustable bolt, known as a toggle bolt and shown by Fig. 2, was introduced. This is made in two parts, a rod or bolt and a plate attached thereto. The construction is clearly shown in the engraving, but several other forms of toggle operating on the same principle are on the market. The plate is held in a vertical position when being installed in the ceiling, and as soon as the end clears the upper side of the lath or fireproof brick, as the case may be, the plate, owing to one end being heavier than the other, assumes a horizontal position. These toggles are generally used to fasten the conduit boxes in place. The boxes support the conduit pipes which run from outlet box to outlet box, entering same a distance of about half an inch.

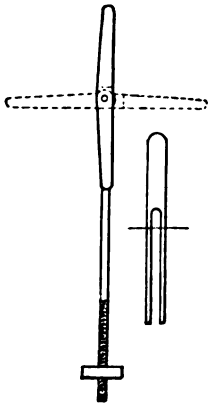


FIG. 2.

When long runs are required and the conduits run six or seven inches below the ceiling, special hangers must be attached to the lower end of the toggle bolt. To show how easily this may be accomplished, reference should be made to Fig. 3. Here two ordinary ½-in. galvanised-iron pipe straps are employed, a small hole being either drilled or punched in the centre to admit the end of the toggle bolt. Short flat-head bolts and nuts ⅛ in. in diameter hold the two straps together, and lock-nuts are provided to hold the combination in position as well as the conduit which rests in the lower part of the hanger.

The device shown in Fig. 3 serves very well on a single pipe, but where four or five

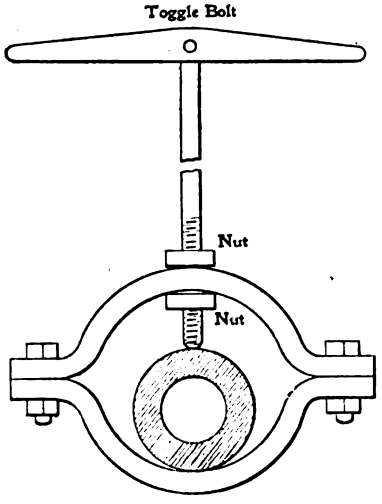


FIG. 3.

conduit lines are to be accommodated some other means must be provided. Fig. 4 shows a simple hanger for this purpose. In the case under discussion the conduits were two feet lower than the ceiling, so that extra-long toggle bolts had to be used. A wrought-iron bar having a ¼-in. hole at each end is slipped over the rods and held in place by two small nuts. In this manner both of the toggle bolts are connected together, and thus support the conduits. In passing under wrought-iron beams, a thin piece of band-iron with hooked ends is fastened to the girder or beam, the band-iron running in the same direction as the conduit or circuit. The conduit is fastened to this band-iron by means of a

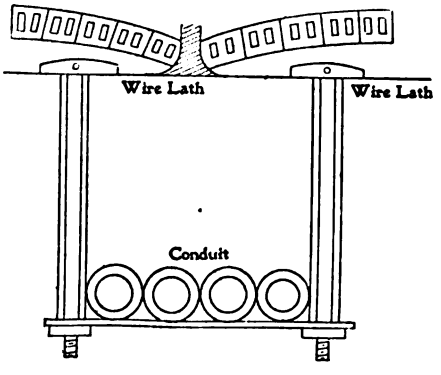


FIG. 4.

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short piece of No. 12 galvanised-iron wire. The long rods mentioned above have a 1¼-in. piece of gas pipe covering the exposed parts.—*American Electrician.*

Notes.

Some months back we were promised very important developments in the construction of arc lamp mechanism. The irreducible minimum had been attained in the number of working parts, and their cost brought down to the same very desirable end. We can certainly do with this lamp when we get it, but the "irreducible minimum" has been reached so many times in this direction that one is inclined to be sceptical. Doubt less we shall be able to describe this invention should it come into the open market.

* * * *

The preliminary notices of the above also stated that both carbons were above the arc and that a magazine for automatically renewing the carbons could easily be attached. This last point is certainly a feature and one wonders why more has not been done in this direction. The trouble of carboning arc lamps, slight though it is, prevents many people from adopting them.

* * * *

It is interesting to hear that further improvements in Nernst lamps are expected shortly, by which it is hoped to reduce the time necessary for heating. Installation hands would be somewhat grateful if a different pair of terminals could be arranged. At present they are absurd. A good deal of work is being done with miniature arcs, but they are a long way from satisfactory. When fitting these particular attention should be paid to the adjustment of the resistance. The writer noticed a type that has a solenoid with a special winding to burn on 100–120-volt circuits without separate resistances. The same lamp is also being used two in series on 200–230-volt circuits with differential mechanism and line resistance. They give a good light and barring the recarboning are a good and useful lamp.

* * * *

Why is it that so many meters leak to their outer covers after they have been fixed for some little time? Some very nasty shocks can be had that way. Most meters are fixed in cellars where the floor is damp and a little care should be taken in handling them. With reference to this, never take an insulation test through a meter—or, if you do, don't expect a good one.

To speak of Japan just now leads one's thoughts mostly to war. But there is an enormous commercial side to the little Easterners. Electricians might do worse than turn their attention that way, where constant work at good wages can be found. The utmost activity prevails there in electrical work, and good hands are much sought after and well paid. Many American hands have been imported—mostly as foremen—and it becomes part of their duty to instil methods of installation into the heads of the native workers. Those who desire to see other parts of the world could profitably start with Japan where wages are high and the cost of living low. Many miles of electric railway and tramway are being laid and public lighting is in full swing. The 10-c.p. lamp is the standard.

* * * *

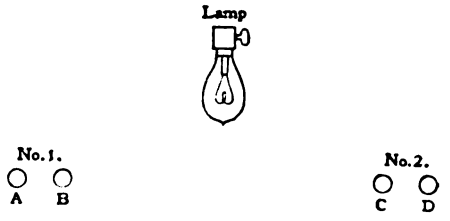
Fresh features are being introduced into this section in the interest of the general installation hand, and opportunities for securing *The Electrical Magazine* at special rates are now being held out to all workmen engaged in wiring, &c.

Upon receipt of a postcard full particulars of this scheme will be forwarded, and, as the aim of the Associate Editor of this section will be to further the true interest of the journeyman electrician, it will be found advantageous if the opportunity is embraced at once.

PROBLEM IN LAMP CONNECTIONS.

A 16-c.p. incandescent lamp is located in a room and connected to the three-point snap switches, A, B, C, D, so that the following results may be obtained: By operating switch A or C, the lamp is turned on or off. By operating switch B or D, the lamp may be made to burn dimly or brightly, a 32-c.p. lamp being used as a resistance. Whatever is produced at No 1, the contrary is possible from No. 2. How is the lamp connected?

L. F. McH.



PROBLEM IN LAMP CONNECTIONS.

[*The above, taken from a contemporary, will doubtless interest wiremen readers, and we shall be glad to publish any solutions offered.*—EDITOR.]

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"Electric Motors."

By H. M. HOBART. Whittaker and Co., Paternoster Square, E.C. Price 12*s.* 6*d.*

In this book the author treats the subject of the design and construction of continuous-current and alternate-current motors in a very clever way. It is assumed that the reader is familiar with the principles of electricity and that he has some knowledge of its practical application. Higher mathematics are not used. The characteristic feature of the work is that the author not only describes and explains, but he treats in a critical way all practical points of importance to ensure a good and economical design. From this critical point of view he also makes comparisons between direct- and alternate-current motors, and his statements are interesting in regard to the development of such motors, motor-generators, periodicity of turbo-alternators, increase in size of transformers, permissible speed variation in alternators, &c. These observations contain many valuable hints in those cases where no special conditions are stipulated. Chaps. iii., vi., and x. deal with the design of continuous-current motors, and chap. xv. is devoted to that of the induction motor. In these the author does not mention any synthetical method for the calculation of the proper dimensions of a motor, but uses the analytical method which corresponds to the character of the treatise. Chap. x. particularly presents this method, and although it entails a considerable amount of time and work, it has many advantages from a practical point of view inasmuch as it greatly enhances the certainty of choosing the best design. Chap. x. is a good illustration of the author's analytical method. In chap. iii. full consideration is given to the commutator and commutation, and in chap. xv. a very clear statement is made of the circle diagram of an induction motor. In chaps. viii. and xvi. will be found a series of modern designs of various manufacturers. Owing, no doubt, to the inferiority, in practice, of the single-phase induction motor, only comparatively few remarks are made regarding this type, and but little is said of the single-phase commutator motor. This is doubtless due to the fact that this type of motor is still in a state of development, although a bibliography of alternating-current commutating machinery shows that attention has been given to the subject. An appendix in English and metric equivalents, with tables relating to copper wires and gauges for practical use, is very well arranged, and tables and values of the dispersion coefficient in motors by various manufacturers constitute a most useful addition. There are one or two points which might be worth the consideration of the author when considering a future edition. In chap. x. on the comparative designs of a 35-h.p. motor, he gives amongst other results (p. 180) that the watts per square decimetre of peripheral surface of the armature for the four designs A, B, C, D, are 28, 34, 53, and 62 respectively, but also if it is considered that the ventilation in case D is somewhat better than in case A, owing to 30 per cent. higher peripheral speed of the armature, the temperature increase of the armature of the motor D will be about 100 per cent. greater than in the case A. A proper comparison can only be made if the heating is the same in all cases. Again, we cannot quite follow the author's motive when in the same comparative calculations on pages 178 and 179 relating to the spool winding, in the cases of C and D, he takes the radial depth of the winding to be about 40 per cent. less and correspondingly the current density about 30 per cent. higher than in the cases A and B. T. H.

"Handbuch der Elektrotechnik."

By C. HEINKE. Vol. VI., Part I.: Electric Lighting and Power Conductors, Circuit-breakers, Fuses and other Protective Appliances by E. Pohl, S. Hirzel, Leipsic: xxiv and 448 pp. 1904.

The opening chapter of this work deals with the various insulating materials employed in the manufacture of electric lighting and power cables, and the other appliances treated of. It contains numerous valuable tables of constants. These include comparative tables illustrating the relative advantages of copper and aluminium, and examples are given of the construction of the cables employed in many of the best-known power transmission systems. The standard specifications, relating to copper, of the German Electrotechnical Association, and of our own Cable Makers' Association are given in this chapter, and the other standard specifications of both Associations, as far as they relate to cable manufacture, are reproduced in later chapters. The heating of electric conductors is next considered from the point of view of the cable-maker, after which the properties of the various insulating materials employed for electric purposes are discussed in detail. The remainder of the 190 pages devoted to electric cables is occupied with descriptions of manufacturing processes and machinery, and of measuring apparatus and methods of

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measurement employed both during, and after the completion of, the manufacture of cables. The second division of the work, pages 191 to 314, after some introductory remarks on the general principles of construction of switches and circuit-breakers, is mainly devoted to the detailed description, with numerous illustrations and sectional drawings, of the various types employed in modern German practice. Numerous tables giving complete details of the dimensions of switches and circuit-breakers forms a valuable feature of this section. The third and final section of the work is mainly descriptive of approved types of fuses and cut-outs, and of lightning guards and methods of protection employed to guard against excessive voltage on high-pressure transmission systems. Here, as in the early portion of the work, the general principles and theoretical considerations necessary for adequate comprehension of the subject are clearly, though briefly, set forth. In common with the preceding volumes, the present one contains very complete name and subject indices. The work contains no less than 395 illustrations, and these are practically informative, and not mere catalogue reproductions. This volume, dealing as it does in a thoroughly satisfactory manner with subjects on which a text-book was badly wanted, is one which should be highly welcomed by electrical engineers.

"Elementare Vorlesungen uber Telegraphie und Telephonie," Lief. 1-6.

(Elementary Lectures on Telegraphy and Telephony, Parts 1-6.) By DR. R. Heilbrun. Berlin: G. Siemens. Price 1*s.* 6*d.* each Part.

A mere cursory glance through this clearly printed and beautifully illustrated work cannot fail to produce a most favourable first impression—an impression which is only strengthened by a closer study of the contents of the book. Assuming absolutely no knowledge on the part of the reader, the author explains, in clear and simple language, the elementary facts and laws of electricity and magnetism, the practical system of units, the construction of the simpler measuring instruments, and primary and secondary cells. Then follows a lecture on wave-motion and sound, completing the introductory portion of the work. The descriptions of telegraph instruments which follow are characterised by extreme clearness and fulness, every detail of construction being carefully illustrated and explained. The author has wisely contented himself with describing a few important instruments thoroughly, instead of attempting to deal with a large number perfunctorily.

The work was originally planned to be completed in five parts, but as it progressed the necessity of extending the limits thus imposed became obvious. We have only the first six parts before us at present, but if the remaining parts are equal to these, we can unhesitatingly say that this work is unsurpassed by any other publication of a similar nature.

"Einrichtung und Betriel Electrotechnischer Fabriken."

(Design and Management of Electrical Engineering Works.) By DR. F. Niethammer. Stuttgart: Ferdinand Enke. Price M. 9.

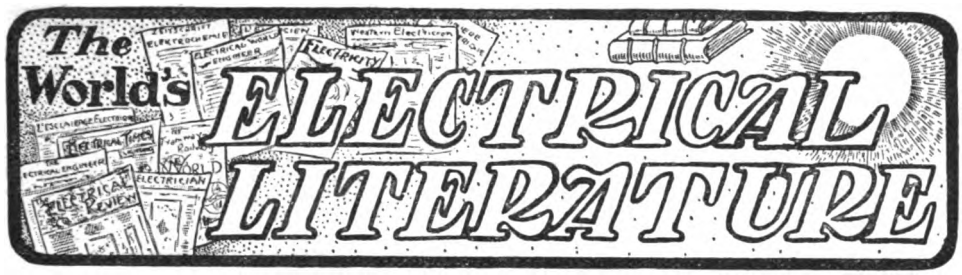
This important work by a leading authority on the subject is sure to appeal to all manufacturers of electrical machinery and apparatus. Starting with a discussion of the general organisation of a manufacturing company, the author goes on to consider the design of the works from an architectural standpoint, and the arrangements for handling heavy pieces of machinery. He then considers the various workshops in detail, dealing with machine tools and the methods of driving them, with portable tools and machines for stamping core plates. Numerous details of the fitting-shop, the foundry, and the smithy next receive consideration. Then comes a very important section on the winding-shop, followed by an account of the methods employed in building up large commutators, and by sections on the erecting-shop, the testing-department, the packing and outside erection of machines. The routine of the offices is next discussed and the concluding section deals with costs and estimating. To the experienced manufacturer as well as to the young electrical engineer this book should prove of great value and interest.

"A Travers l'Electricité."

By GEORGES DARY. Paris: Nony and Co.

The fact that this work is now in its third edition shows that it appeals to a considerable number of readers. It contains 460 large and well-printed pages, and is profusely illustrated. It deals with every conceivable practical application of electricity. The treatment is, it need hardly be said, very simple and popular, as the book is intended for the general reader, by whom it may be read with pleasure and profit. The illustrations are of unequal merit, some being good, others poor; many of them are of a somewhat sensational character—such as the night torpedo attack on a battleship; these will, no doubt, be relished by the class of reader for whom the book is intended; while the technically trained man will not fail to derive some genuine amusement from a perusal of the book.

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The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects are arranged *under subject-matter* in this section. Suitable references are made to the names and dates of the various papers, and the whole forms an index guide of considerable importance and value.

Power.

Articles.

*Niagara Power at Buffalo.	*Elec. Wrld. & Engr.* 3, 10/12/04.
Pitman Hydraulic Wheel. J. Dary.	*L'Electn.* 3/12/04.
Rotary Engines. F. Neithammer.	*Elec. Wrld. & Engr.* 3/12/04.
*Grounded Transmission Systems. J. S. Richmond.	*Elec. Rev. N.Y.* 3, 10, 17, 24, 31/12/04.
Combined Lighting and Heating Plant, Ohio.	*Elec. Wrld. & Engr.* 3/12/04.
The Conical Wind Motor. A. Gradenwitz.	*Elec. Rev.* 16/12/04
La Goule Hydro-electric Plant. F. Koester.	*Elec. Rev. N.Y.* 10/12/04.
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Electrical Operation of Textile Factories. H. W. Wilson.	*Manch. I. E. E.* 17/1/05.
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*Electric Repairing, the Commutator. N. G. Meade.	*Machy. N.Y. Dec./04.*
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Multiple Voltage Control of Motors. N. G. Meade.	*Power, Dec./04.*
*Electrical Problems. W. H. Wakeman.	*Power, Dec./04.*

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

New Catalogues.

POWER.

Destructors.—THE HORSFALL DESTRUCTOR CO. of Leeds and London has issued an illustrated booklet giving particulars and photographs of the chief destructor insulations it had put down. It contains much valuable data, and should be in the hands of every town councillor.

Electric Lifts.—SMITH AND STEVENS, Queen's Road, Battersea, S.W. A 40-page booklet deals concisely with the specialities of this company in the way of electric lifts. It is prefaced by some twenty odd pages of useful information on lifts generally, but we refer our readers to the Manufacturers' Section of this month, in which a detailed account will be found.

Electric Cranes.—ROYCE, LTD., Manchester, forward their latest electric crane list. They cannot be accused of parsimony in the style and size of their publications if the example before us is a fair specimen. It is a substantial catalogue of over 100 pages, and its illustrations are nothing if not convincing; at least they should be to a man wanting an electric crane. The book is now in its third edition, and will well repay careful perusal by those interested. We shall publish illustrated particulars in an early issue.

Colliery Work.—THE ST. HELEN'S CABLE CO., LTD., Warrington. Colliery cables form the subject of this company's latest publication. It contains particulars of dialite and its advantages, together with several reports of tests on dialite cables. The application of these cables to colliery work is clearly described and illustrated with diagrams and drawings showing methods of fixing in shafts and workings.

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Motor Gauges. — NALDER BROS. and THOMPSON, Ltd., 34 Queen Street, E.C., have just issued particulars of their new motor gauge, an instrument intended to indicate at a glance the power, or horse-power, absorbed by a motor. The instrument takes the form of a dead-beat ammeter of the soft iron solenoid type, the movement of which is screened to eliminate errors due to external fields. An improved air-damping device is also fitted making it absolutely dead beat under all conditions.

CENTRAL STATION PRACTICE.

THE GENERAL ELECTRIC Co, Queen Victoria Street, E.C. Section X of this company's price-list is now before us, and it contains full details of the high- and low-tension switchboards manufactured or sold by the Company. The Progress Sheet No. 55 was also enclosed, and gave particulars among other things of the Angold Automatic Suspension gear for Arc Lamps.

Coal Conveyors.—GRAHAM, MORTON AND Co., Leeds, have sent us a nugget, in other words a little book full of pictures of what they have done or are prepared to do in the way of electric transporters, bridge cranes, and aerial rope-ways. It has been tastefully prepared, and should make a fitting forerunner to more bulky publications.

Steam.—BABCOCK AND WILCOX, LTD., Farringdon Street, E.C. *Steam* is the title of a handsome publication issued by Messrs. Babcock and Wilcox. It is in its fifth edition and quite eclipses all predecessors. No Central Station engineer can afford to be without this valuable treatise on the generation of steam, for such it certainly is. The edition is handsomely printed on art paper, and no fault can be found with the typography. It is complete in every respect, even to the index, and a glance down this puts one in touch with what one wants inside.

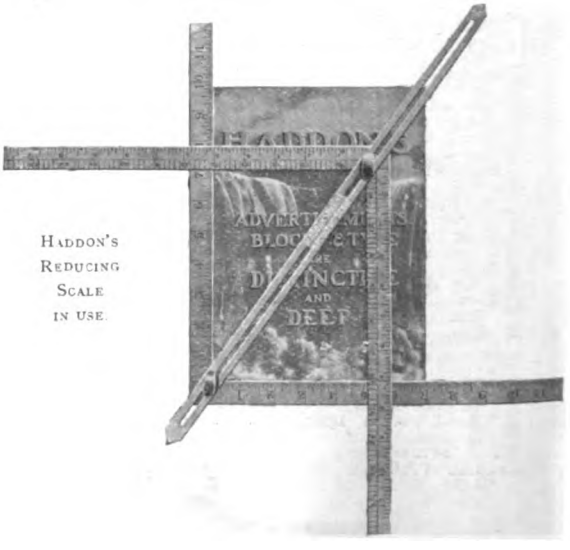
Flue Gas Analysis.—THE SMOKE PREVENTER Co., LTD., Blackburn, send us a copy of their list describing the "Krell" CO_2 Recorder. It is fully illustrated, and a concise description of the apparatus is given. Central Station men will find the list very useful. From the same source comes also a leaflet dealing with the E.S.E. stoker.

Glover's Calendar.—W. T. GLOVER & Co.'s calendar for 1905 is "streets ahead" of its predecessors. The slips formerly pasted have been neatly perforated and can be readily torn off. The entire calendar can also be examined without damage to "the days that are yet to come." The extracts from the I.E.E. journal are as good as before, and the solidity of these, where it exists, is relieved by humorous passages which come as a welcome relief. Many of these latter, for there are not a few, are in verse and doubtless the gems of such as have appeared are already running in the heads of station men and switch-board attendants. The portrait section is given over to chiefs of supply stations, but the many facial expressions must evidently not be taken as indicative of the financial condition of their respective undertakings.

Calendars, Diaries, Pocket Books, &c. —AT the close of the year we received the following: From the Fuller Wenstrom Electrical Manufacturing Co., a handsome table calendar; E. Green and Son Ltd., Wakefield, a substantial paper weight; Mather and Platt, Ltd., Salford, a pocket case and diary; Clarke, Chapman and Co., Gateshead, leather pocket case and diary; Crompton and Co., Ltd., handsome leather pocket case and price-list; Giepel and Lange, St. Thomas's Street, Southwark, S.E., small pocket book and diary; The Simplex Steel Conduit Co., neat pocket book and diary bound in leather; The St. Helen's Cable Co., silver plated pocket knife; Messrs. Dorman and Smith, a pipe cleaner and parcel carrier in one, which we are informed on a card is not a sample of switchgear; The Hart Accumulator Co., blotting pad; The Electrical Power Storage Co., substantial blotter with calendar and blotter diary together with much valuable information on batteries.

A USEFUL DEVICE FOR ENGRAVERS AND ENGINEERS.

We referred in our December issue to a patent reducing scale made by J. Haddon and Co., Salisbury Square, Fleet Street, E.C., and we are now pleased to present an illustration of one in actual use. The device is in brass and comprises two sets of scales, each at right angles, fitted with thumb nuts, and adjustable towards or away from each other in the slot in a steel support (*see* illustration). The scales are placed over the subject for reduction and adjusted for the desired width when the depth of the block when finished will be read off on the vertical right-hand scale, and its area will be enclosed by the four sides of the scale. This last is a valuable feature as further measurements are not needed and the actual dimensions of what will be the block are conveyed to the mind's eye. We understand that the scale will be sent on approval to all interested in such a device.



HADDON'S REDUCING SCALE IN USE.

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FOUNDED AND EDITED BY

THEO. FEILDEN.

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LONDON'S POWER SUPPLY.

WHAT is likely to prove the most momentous event in electrical circles this year is the proposal for the provision of adequate means of giving London a "bulk" supply of electrical energy.

When suggestions were first put forward for the supplying of London with electric light, Mr. Ferranti championed the cause of concentrating the power-plant into one or two gigantic stations, and backed his proposals up by building what was at the time a large station at Deptford, equipped with monster units delivering one-phase current at 10,000 volts. His daring scheme was, however, nipped in the bud when London was divided into districts in which separate supply orders were granted to either companies or municipalities, and a temporary victory was thus early secured for decentralisation of plant. Years have gone by, and these concerns have meantime developed their custom to that encouraging stage which brings a desire to acquire either fresh territory or become vested with new powers. To-day the City and County of London is supplied with electricity by thirty-two local authorities and twenty-two companies who operate between them seventy power-plants in various districts. For years these undertakings as they have sprung up have developed a good lighting load, and a power load from such motors as they could connect to their mains, but powers have not been granted for supply in bulk. A class of customer has thus been neglected which increases the load factor and makes the undertaking so much more remunerative. The highest load factor secured among the London stations is, according to published records, 28 per cent., while the lowest is about 11 per cent., and these figures clearly indicate the character of the supply given. Hitherto there has been no attempt made to supply the very large power user in London who has continued to depend on steam or gas for turning the wheels of his factory machinery. It would almost seem that the work of expanding the scope of the various undertakings had been conducted with the utmost indifference to this long hour consumer, whose acquisition meant the more profitable employment of plant otherwise idle. True, the Parliamentary powers granted did not include undertakings of this kind as customers to whom energy could be supplied in bulk, but if Parliament can now be appealed to for further authority, why should this application have been so long delayed? With the opening of the present session we find a very mixed state of affairs among the numerous electrical caterers of which London is now possessed. The largest of the companies are seeking to obtain powers to supply electrical energy in bulk with a view to extending their custom among the class of power user to which we refer above. This procedure has occasioned uneasiness in the municipal camp, and steps are to be taken to oppose the move of the companies, avowedly in the interest of the municipalities who will give a supply of electricity in the future. Among the

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bills for bulk supply, however, by far the most important is that of the Administrative County of London and District Electric Power Co., which seeks to establish new stations within the proposed area, to furnish electric power on a very large scale among, what we have observed to be, the cream of the customers. According to the text of the Bill, it is desired to furnish energy to two distinct areas in London; the industrial and the non-industrial. In the former, power in bulk is to be supplied and also light for the same consumer, and in the latter the same privileges are sought with street lighting in addition.

There is a significant coincidence about the lodging of these particular Bills in Parliament at one and the same time, and quite a number of surmises suggest themselves in consequence. To many it may appear that the existing companies getting wind of the new scheme, have acted in self-defence by applying for almost identical powers. Others might suppose that both parties are in collusion, and are aiming at a gigantic monopoly to outwit the municipalities, who would thus be left with the merest "pickings" among London's consumers of electrical energy. It may be that the newer and larger concern seeks to bring about healthy competition among the present undertakers, and thus prevent either stagnation or the maintenance of fancy prices. The last conjecture appears to us the most reasonable as regards the motive of the Administrative County of London and District Power Co., while the first seems to explain the attitude of the existing companies in applying for an extension of their present powers.

Time, of course, will show whether our anticipations were near the mark, but at the present juncture there can be no doubt as to the magnitude of the opposition to the Bill. This is likely to be of the most strenuous character, and if it is properly engineered may succeed in its object, though it will only be after a sharp struggle, as the other side has many a valiant debater to help it through.

The scheme itself is a most ambitious one, and its promoters lack neither zeal nor ability to bring it into effect. Its engineer is Mr. C. H. Merz, who is evidently not content to rest on the laurels he has won at Newcastle, but seeks nothing short of the world's greatest city to conquer, or rather to electrify. A capital of £5,000,000 is suggested as the amount with which to start operations, but if this is compared with the twenty odd millions which the existing supply authorities have invested in the development of their undertakings, it does not appear by any means adequate. The nature of the work involved, however, will not entail such heavy outlay as, first, the plant will cost less per kw. and, secondly, there will be no need for expensive transforming stations to convert the current to any other form than that generated. The operations of most of the London supply companies have been much handicapped by being saddled with costly buildings, plant, and switchgear, especially since they have extended their systems with polyphase generating plants. The new concern can commence operations unencumbered by these drawbacks, and, moreover, it will have the advantage of the most modern designs in the way of plant and mains, while we must not forget also that it would have at disposal the services of engineers well trained and tried in power supply methods.

It is worthy of notice that the company desires to assume the *rôle* of supplier to a number of "distributors," who would receive energy at rates much below those at which they could themselves generate the same amount of energy. In this capacity it would furnish any of the existing undertakings with electric power in bulk, even those larger concerns who now are aiming to secure somewhat similar privileges on a less extensive scale. This looks rather hard on the older authorities who have struggled for years certainly with a difficult problem, and are only now beginning to enjoy the fruits of their labours. In this respect the municipalities fare worst, as they are restricted to the most unprofitable class of consumer, and, unless they can bring in the long hour customer, will do little else than mark time.

We shall watch the proceedings in connection with this important issue, and as they develop shall deal further with them in our columns.

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TRIBUTES

From both Sides of the Water:

Remarkable Unanimity of Leading American and British Electrical Engineers and Scientists on the American Tour Souvenir Issue of "The Electrical Magazine"

From America.

PROF. ELIHU THOMSON, President of the International Electrical Congress, 1904, speaks highly of the number and testifies to the labour expended in its production. He writes:

"MR. THEO. FEILDEN,—*My Dear Sir, the Souvenir issue of* THE ELECTRICAL MAGAZINE *reached me a day or two ago. It is certainly very creditable to you, and must have involved a large amount of labour. I am not surprised at the exceptional demand for the number. The text, the printing, and illustrations are all that could be desired. Thanking you for the courtesy extended, and remembering our pleasant meeting when you were in America,*

"*I am,*

"*Very truly yours,*

Elihu Thomson

DR. A. E. KENNELLY, Professor of Electrical Engineering at Harvard, and one of America's greatest authorities on electrical matters, writes the Editor-in-Chief at some length regarding the Anniversary issue. Among other things, he says:

"*This Souvenir Number is very interesting and shows evidence of much care and labour. The reviews it elicits and prints from fifteen British members of the party, in addition to your own, and to those of foreign members, are specially valuable and instructive to electrical engineers on this side of the water, because although a visitor may not feel inclined to state all that he thinks about a country that he visits, yet whatever he does say is evidence of some contrast between that country and his own. When such remarks are made by members of the travelling public they are apt to carry little weight, but made by members of a party of engineers they become of expert value and assume importance. The views expressed seem to me singularly just and applicable. It has given*

Call Address
"Edison, New York

From the Laboratory of
Thomas A. Edison

REC'D 2/3/05
ANS'D 3/3/05

Orange N.J. Feb. 21, 1905.

Theo. Feilden, Esq.,
Electrical Magazine, 4 Southampton Row,
Holborn, London, W C., England.

My Dear Feilden:

Yours of the 8th received, replying to same wish to say that when the Electrical people do anything it is up to date and excellent, that is the case with your Souvenier Editions its hard to beat.

Yours truly,

Thos A Edison

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me great pleasure to read this souvenir copy. The illustrations are excellent, and your snapshot photos are wonderfully successful. Altogether, I think you are to be highly congratulated upon the success of the number.

" Yours very truly,

A. E. Kennelly.

MR. BION J. ARNOLD, President of the American Institute of Electrical Engineers (1904), is so pleased with the issue that he intends to keep it by him for reference as a Souvenir of the Tour. Mr. Arnold writes:

" My Dear Mr. Feilden, — I am in receipt of THE ELECTRICAL MAGAZINE *for January, containing your complete description of the American Tour of the Institution of Electrical Engineers.*

" I have only had time to glance through the issue, but from what I have seen I am very much pleased with the way in which you recorded the principal and minor events incidental to the trip, which those of us who were fortunate enough to accompany you most thoroughly enjoyed. I wish to congratulate you upon the enterprise and ability shown by you in the preparation of this issue of your valuable Magazine, which I shall keep as a souvenir of the interesting visit of your countrymen with us.

" Wishing you much success, I am,

" Yours sincerely,

Bion J. Arnold

FROM the present President of the American Institute:

" My dear Mr. Feilden, — I have just received the Souvenir issue of THE ELECTRICAL MAGAZINE, *and I congratulate you on the very interesting account of the circular tour organised in connection with the International Electrical Congress. The many snapshots and individual likenesses must make the Souvenir number a most pleasant memento to all who took part in the tour, whether they were visitors or hosts. I have already ordered three extra copies of this issue, which were at once seized upon by friends who were much interested in the number, and I enclose my cheque for six additional copies.*

" Again congratulating you on the admirable production,

" I am, with many kind regards,

" Yours very truly,

" J. W. LIEB, Jnr."

MR. T. COMMERFORD MARTIN, Editor of the *Electrical World and Engineer*, New York, one of America's greatest electrical weeklies, speaks highly of the Souvenir issue, as will be seen from his letter herewith:

" My Dear Mr. Feilden, — I have received copy of the Souvenir Issue of THE ELECTRICAL MAGAZINE. *This is very much appreciated and, as you will see from the enclosed clipping, we have taken the opportunity of paying our respects to it as promptly as possible."**

" I should certainly like to secure one or two extra copies, and in the meantime would ask you as a great favour to me to send one copy each to the enclosed addresses. I am expecting to be in England about the middle of March, and shall be visiting the places named, and your magazine will give my friends a better idea of the trip than all I could ever tell them. Thanking you for the prominence which you have been good enough to give me and my own humble work in this special issue, believe me,

" Yours truly,

T. Commerford Martin

DR. W. J. MORTON, a noted American electrotherapist, who presided over the Electrotherapeutic Section of the International Electrical Congress (1904), writes in pleasing terms of the Souvenir issue:

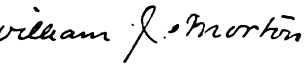
" My Dear Mr. Feilden, — I have received your remarkably handsome copy of THE ELECTRICAL MAGAZINE, *showing your most interesting record of the American Tour. I have turned it over page by page, enjoying the descriptive text and the charming little prints of photographic reproduction. Your effort is indeed a wonder of human industry and assiduity,*

* See page 246.

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and I congratulate you upon the fine appearance presented by your work. This number of THE ELECTRICAL MAGAZINE *will ever remain an interesting reference-book from many points of view. I wish you success in all your work, and I thank you warmly for your courtesies extended to me.*

"I am, sincerely yours,



MR. C. L. EDGAR, President of the Boston Edison Company, and a prominent Central Station engineer, contributes to the general testimony a most valuable encomium, which reads as follows:

"My Dear Mr. Feilden, — I am in receipt of a copy of your special number . . . having recently subscribed for your Magazine. . . .

"You certainly are to be congratulated on the large amount of interesting information which you have given in this number, containing as it does so many good portraits and snapshots taken by the visitors during their trip to America. It will be a valuable adjunct to my permanent library.

"Yours very truly,



MR. J. M. WAKEMAN, Vice-President and General Manager of the McGraw Publishing Company, New York, thinks the Souvenir issue is worth keeping, for, in the course of a letter to our publishing department, he says:

"One copy of the Magazine came into this office addressed to Mr. Martin which I have had an opportunity of looking over, and I wish to congratulate Mr. Feilden upon the interesting and excellent manner in which he has handled the subject of the tour of the members of the British Institution of Electrical Engineers. I should be very glad indeed to receive a copy of the January issue, so that I might bind it and put it in my library as an interesting record."

MR. CALVIN W. RICE, Consulting Engineer for the General Electric Company and Vice-President of the American Institute of Electrical Engineers, writing to Mr. Feilden from the New York office, says;

"I assure you of my admiration for the excellent edition which represents so much painstaking effort."

THE ever-courteous Secretary of the American Institute of Electrical Engineers, writes:

"Dear Mr. Feilden, — I beg to acknowledge receipt of your kind letter of February 11. *. . . I wish to thank you most heartily for your kindness in remembering us by sending copies of the Souvenir Issue of* THE ELECTRICAL MAGAZINE. *Its perusal has been a great treat to all of us, and I wish personally to congratulate you on the perfection of the work. The personal vein and the high appreciation of the efforts of our committees, makes your record of experience especially gratifying. It is in my opinion the most complete existing report of our tour, and I fully appreciate the great labour necessary to bring it into proper form. I also wish especially to commend the personal expressions of many of your colleagues who were given this opportunity of visiting and examining various engineering works, as well as gaining a good impression of the most important part of the United States. All who have had an opportunity to examine this publication have expressed the very highest opinion of its interest and value.*

"I enclose one dollar, for which I would be pleased to have you send me three copies of the Souvenir number of your Magazine.

"Yours truly,

"RALPH W. POPE."

MR. W. A. LAYMAN, General Manager of the Wagner Electric Manufacturing Company, St. Louis, U.S.A., writes to Mr. Feilden:

"My Dear Sir, — I am in receipt of the Souvenir Issue of THE ELECTRICAL MAGAZINE, *and beg to compliment you on its comprehensive character and handsome appearance. I shall take pleasure in having this volume bound in permanent form so that I can preserve it as one of the very interesting mementos of the Exposition period. I have so far only been able to rapidly glance over the interesting material you have compiled, but shall*

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later on give it a careful reading, and shall expect to derive considerable pleasure from it.

"Yours very truly,
"W. A. LAYMAN."

MR. GEO. W. DAVENPORT, writing from the Niagara Falls Power Company, says:

"The Souvenir Issue of THE ELECTRICAL MAGAZINE, *containing an illustrated record of the tour of the British Institution, is admirably made, and the account of the memorable trip extremely interesting."*

MR. S. W. STRATTON, Principal of the Washington Bureau of Standards, writes:

"The number is exceedingly well got up. Our subscription fund for the current year is exhausted, but if possible we will add THE ELECTRICAL MAGAZINE *to our list of publications after the beginning of the next fiscal year."*

An Order by Cable.

So great was the demand for the Souvenir Issue that copies were taken up by cable during the "rush" period. Dr. Lee de Forest, the American pioneer of overland wireless telegraph work, cabled us an order for four dozen copies which we were just able to supply from the quickly diminishing stock. He has since written his appreciation, and requested us to write his name as a regular subscriber to the Magazine.

From Great Britain.

ROBERT KAYE GRAY, past President of the Institute of Electrical Engineers, and Chairman of the India Rubber, Gutta Percha, and Telegraph Works, and other prominent men, write with expressions of approval, in addition to which an extraordinary large number of other eulogies have been received, not only from members who took part in the Tour, but from electrical men of every grade outside the party, on both sides of the water.

DR. R. T. GLAZEBROOK, of the National Physical Laboratory, who was a delegate from the British Institute of Electrical Engineers to the Electrical Congress, sends us a pleasing compliment:

"Dear Mr. Feilden,—I thank you for the copy of the Souvenir Number of THE ELECTRICAL MAGAZINE, *and have read it with great interest. You have succeeded in putting together an amount of information with regard to our tour which I am glad to have, and I must congratulate you very sincerely on the manner in which you have carried the work through. I trust you will find the number in every way a success.*

"Yours very truly,
"R. T. GLAZEBROOK."

PROF. J. D. CORMACK, of University College, London, substantiates our claim for the Souvenir issue as a record and work of reference:

"Dear Mr. Feilden,—I must congratulate you heartily on the result of your efforts. Your Birthday Number will be a most interesting souvenir of the tour, and a valuable work of reference."

"Yours faithfully,
"J. D. CORMACK."

MR. G. C. LLOYD, the courteous Secretary of the Institute of Electrical Engineers, who accompanied the party throughout the tour writes:

"Dear Mr. Feilden,—Please allow me to offer you my hearty congratulations on the issue of your magnificent Special Number. I think the collection of portraits and photographs is truly marvellous, apart from the great interest which attaches to it. The whole production, illustrations, and descriptive matter together, does wonderful credit to your indefatigable energy and skill. Mr. Carruthers of the White Star line, Cockspur Street, rang me up a few days ago to know whether he could procure a copy. Perhaps you will already have thought of sending him one.

"Yours very truly,
"G. C. LLOYD."

Pressure on our space compels omission of many other interesting letters.

Views of Transatlantic Friends on the A.I.E.E. Circular Tour.

Reprinted from the "Electrical World and Engineer," New York, Feb. 28, 1904.

A LARGE and interesting souvenir number of our esteemed contemporary THE ELECTRICAL MAGAZINE, of London, has just reached us. It contains a remarkably full account of the circular tour from England to St. Louis and back, written by one of the party. It also contains expressions of opinion from fifteen members of the British party,

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which party travelled ten thousand miles in a little more than five weeks. It is pleasing to observe the glad memories that have been left in the minds of our visitors by their American reception, both in the United States and in Canada. All views refer clearly to the recognised efforts made for the pleasure of our guests. There never was a doubt beforehand as to the promise and permanence of the friendship which would be established by the visit, between men of the same line of industry and the same trend of ideals, whose homes lie respectively on the eastern and western sides of the great ocean. Since many of the visitors made on this occasion their first trip to our shores, their views upon the points that particularly struck them on the journey are of particular interest. The salient expressions of remark are both technological and sociological. The sociological views are not seemingly different from those frequently expressed by foreign visitors generally. The technological opinions are, of course, expert opinions, and so far as they are offered, they are not of everyday occurrence, but are peculiar to a class of trained technologists, or engineers. The consensus of expressed comment refers to the large scale upon which industrial undertakings are carried on, the boldness with which they are attempted, the fine capacity for organisation frequently displayed in such work, and the rapidity with which valuable improvements are spread and adopted. The uniformity of type in plants and machinery, due to standardisation, was also noticed.

The sociological views are of special import from their bearing upon industrial development. The democratic nature of all actions and institutions is specially noticed, with its disadvantages or weak points, as well as its advantages or strong points. Lavish expenditures are noted as the order of the American age, and it is observed that the men in charge of undertakings are remarkably youthful and unconcerned with precedent or preconceived opinions. All of these views are evidently well founded. They refer to conditions that are the logical outcome of the particular environment presented by a relatively young country of large dimensions, inhabited by the more enterprising offshoots from a number of European communities. It is of great importance that the men engaged in industrial development of one country should clearly comprehend the general nature of the conditions that confront their collaborators in other countries, respectively. This mutual understanding not only leads to an enhanced mutual respect, but it also leads to a greater unity of purpose and endeavour.

The problem of supplying electric light, or of electrically transmitting power to communities, is physically and electrically one and the same in all essential respects all the world over, just as there is everywhere but one Ohm's law and one mechanical equivalent of heat. It is the difference of conditions, not only topographical and physical, but also largely legal, traditional and sociological, which changes the problem from place to place, so that the mental attitudes of engineers toward an industrial undertaking are widely different in different countries. A superficial estimate might lead to the error of supposing that the difference in standpoint lay in the men; whereas, to a very large extent, the standpoints are the outcome of the local conditions. We hope that occasions for an interchange of courtesy between electrical engineers of different countries may present themselves at frequent future intervals for the benefit of visits paid to each in succession, in order to foster the friendliness developed by such gatherings, and also to enable the local conditions in the respective countries to be clearly apprehended by their foreign *confrères*. The story of the tour is well related in this clever volume of over 150 pages, illustrated by numerous snap-shot photographs and handsome pictures of objective features of interest at the St. Louis Exposition, and *en route*. A large amount of work must have been entailed in the preparation for publication of the story. The "report" thus afforded deals, however, with the English trip, and it would be very interesting to see something of kindred character from our other visitors, as, for example, those from Italy. They could hardly be expected to take exactly the same view as our English friends, and this continental or Italian survey would be all the more interesting from that very fact.

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Electric Power for Industrial Purposes. CONCISE information has long been needed on the comparative value of isolated power plants and concentrated stations supplying in bulk. We are pleased to note that this has at last been compiled, and by no less an authority on power matters than Mr. J. T. C. Snell, in a paper presented to the North East Coast Institute of Engineers and Shipbuilders. Before dealing briefly with this valuable compilation we should like to express our wonder why papers having so practical an aspect are not read either at the Institution or one of its local sections. A short time ago Mr. Snell took an equally important document to the Civil Engineers, which might have found its way in *The Journal* with every advantage to it. In the present paper Mr. Snell clearly sums up the pros and cons for both isolated and concentrated plants. On grounds of capital cost per kilowatt and better load factor he gives the palm to the concentrated station, supporting his arguments with curves and diagrams. These we shall reproduce in our next issue, but for our present purpose we give a small table

Load Factor.	Units per Kw. Demanded.	Price from Power Supply.	Price from own Local Station.
Per cent.		Pence.	Pence.
15	1,314	1.5	1.75
20	1,752	1.25	1.45
25	2,190	1.125	1.25
30	2,628	1.00	1.10
35	3,066	0.875	0.95
40	3,504	0.800	0.90
50	4,380	0.75	0.75
60	5,256	0.68	0.65
70	6,132	0.66	0.58
80	7,008	0.62	0.50

which is of importance and conveys a good idea of the comparison affected. In the second part of the paper—it is in two sections—polyphase and direct currents are compared, and here again some instructive figures are put forward. A glance at the following table will show how closely the two types of motors run each other under the head of efficiency, though the difference in weight is very marked with the direct-current machine:

EFFICIENCIES OF ELECTRICAL MOTORS.

Three-Phase Induction Motor – 220 volts.				Direct-Current Motor – 220 volts.		
Horse-Power of Motor.	Speed.	Weight lbs.	Efficiency.	High Speed.	Weight lbs.	Efficiency.
			Per cent.			Per cent.
¼	1,375	45	67	1,600	100	67
½	1,410	80	76	1,550	150	74
1½	1,420	100	82	1,450	180	78
2½	1,420	150	83	1,320	280	80
3½	1,425	210	86	1,280	365	82
7	1,430	340	86	1,250	560	83
9	1,430	520	87	1,100	700	84
11	965	750	86	950	1,100	84
18	965	850	88	850	1,320	85
25	965	1,050	89	750	1,570	87
30	965	1,300	89	720	2,740	89
45	720	1,700	90	640	3,240	91

Overland Wireless Telegraphy. UNDER the auspicious guidance of Dr. Lee de Forest overland wireless telegraphy is developing rapidly in the United States. That indefatigable pioneer, writing to us at the end of last month from Key West, Florida—a name our readers will remember from the Hispano-American war—says; "I am down here to open the first large United States Navy wireless telegraph station; its power is 35 kw." Our eminent correspondent goes on to explain that the antenna consists of three fans, each 300 ft. long, and that the wave length measures approximately 5,900 ft. or over a mile! It must be very

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encouraging to know that messages are being regularly transmitted over 1,450 miles of country between Chicago and Cleveland, the power plant in this case being only of 2 kw. capacity. A most promising experience has also been obtained with ships using 1 kw. apparatus at sea, it being possible to communicate with New York even up to 100 miles distance. Dr. de Forest is most sanguine of bridging the Atlantic by wireless, and has such faith in the capabilities of his system that he hopes to anticipate Mr. Marconi in establishing actual communication. He has certainly done a great deal for long-distance telegraphy in America, and we see no reason why his efforts should not be crowned with so magnificent an achievement, and at no distant date. We shall hope to give further details of Dr. de Forest's splendid work in an early issue.



A Set-back for One-phase Traction.

READERS of this Journal will recall the work of B. J. Arnold in the field of one-phase traction from Mr. Mordey's articles on the subject. Mr. Arnold had developed a system combining the one-phase motor with pneumatic storage tanks, so contrived that the reserve power of the train when available, such as when coasting or braking, compressed air into reservoirs, which could return this air to assist the motors when starting. A disastrous fire put an end to the early experiments, but meantime a company had been formed which was to equip a length of line between Lansing and St. Louis on the new system. After the fire it was hoped that the work might be carried through to completion, but we learn with regret from a contemporary that financial difficulties have caused the abandonment of the trials, at any rate on this particular line. With characteristic American enterprise, however, the track and overhead equipment is to be utilised and cars run by direct current supplied from rotary converters in substations. A company has been formed, entitled the Lansing Urban Traction Company, which will improve the lines in Lansing City and develop the suburban route also. The hopes of witnessing an interesting experiment in one-phase traction are thus dashed for a time. What appears to us the most galling feature of the change is the mongrel aspect of the power plant feeding the new line. A small steam-driven station in Lansing feeds the local lines, and a combined steam and water power plant supplies the interurban. The latter comprises a double current generator feeding high voltage to the transmission line for the substations, and direct current locally, so that the alternate current which was to have actuated the whole system is not even given an individual generator with which to console itself. Further, the power supply is not in the hands of the operating company, but owned by a separate concern. We wish Mr. Arnold better luck in his next venture.



Light on Lamps.

IN this issue we publish a striking article from the pen of Dr. J. A. Fleming, F.R.S., on the much discussed subject of electric lamps. We are sure this will be read with the closest interest; at any rate we specially commend it to the notice of our readers. The deficiencies of the electric glow-lamp are proverbially notorious, but quite frequently the significance of these drawbacks is not realised in the way it should be. Dr. Fleming, who has had more experience of the electric glow-lamp and other electric lamps probably than any living scientist, succinctly explains these failings in readily comprehensible terms, and our readers will, we are sure, be able to remember his delightful comparisons without the slightest difficulty. The extraordinary waste of energy in the production of light is a most fascinating subject, and more so to the electrical engineer, and for several reasons. First, his experience so far with the artificial production of light carries with it the conviction that to him and him alone, will be intrusted the manufacture of light in the future. Secondly, despite the present obstacles in the way of a satisfactory solution of the problem he feels is essentially his to grapple with, his work so far has contained such grains of encouragement as stimulate his belief in the attainment of ultimate success.

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Thirdly, the agency he commands encloses within itself the elements which, when assembled in correct relationship, will give him what he seeks to secure,—light without heat. In this latter respect Dr. Fleming's speculations on the lamp of the future are of intense import, coming as they do from one who is given the right to lend wings to the imagination.

Other matters are dealt with in the article which touch upon less distant problems; namely, the standards of comparison, and the methods of measurement of different lamps. There is a smack of humour in our adoption of a gas flame as a standard by which to compare the candle power of two lamps, though the humour is—to be Irish—the least serious item. All flame standards are subject to grave variations on account of a moist atmosphere, barometric pressure and carbon dioxide, factors which may influence the standard value some 4 per cent. It appears advisable, therefore, that the standard incandescent lamps recommended by Dr. Fleming should be adopted, when the comparison will be more compatible and certainly more reliable. The actual photometry of the lamp also receives due consideration at the hands of Dr. Fleming, and the reasons he advances for the adoption of his methods are certainly convincing enough, and merit notice at the hands of glow lamp makers in this country. Now that several lamp factories are in full swing in this country it behoves those responsible for the quality of their products to take full advantage of the researches of scientists, who are better fitted to advise in matters of moment to them than they are themselves. Such work as that carried out by Dr. Fleming at the Pender Electric Laboratory must of necessity be of great commercial value, and should receive full recognition by those in whose interests it is undertaken.

Trouble on New York Subway.

NEW Yorkers have recently realised the meaning of a temporary return to antiquated methods of transport, judging by the effects of the strike of the Elevated and Subway operators on their methods of locomotion. The disturbance is untimely, and apt to reflect seriously on the operating results of the Interborough Rapid Transit Company at the end of the year, because its effect will certainly not be removed at once and must continue to disturb the traffic for some time. Eruptions of this kind are always to be deplored, as neither side gets justice at the hands of the public, and the masters quite frequently gain nothing by a bad business not of their own making. In the present instance, higher wages and short hours seem to have been demanded and persistently refused. The men have taken the law into their own hands and imperilled the safety of the public, in whose interest a "scratch" train service was put into operation. The incident gives rise to speculation as to what will be London's experience when the tubes are getting into working order, especially as their organisation and management are essentially American. In justice to the operators it can safely be said that their task, though a simple one, imposes considerable nervous strain, which cannot be taxed beyond certain limits, and any attempt to extend these boundaries—which after all are of a physical character—must bring serious consequences. On the surface it appears the height of folly for a section of electrical workers to kick against conditions which to an outsider are other than exacting, but the real trouble must be sought beyond this superficial aspect of it The constant straining of eye and brain on certain definite objects, such as signals and track, must bring on fatigue of these organs to an extent demanding rest at more or less frequent intervals. If, as we hear, the motormen on the New York Subway and Elevated are kept at their posts for eleven hours at a stretch, then we think that concessions for a reduction of this time should be granted. Further, the continuance of the service at such obvious expense of the employees is carrying the spirit of economy beyond the bounds of reason into a stage at which the public safety is threatened. As far as London is concerned the chances of discontent would appear greater, as the traffic is confined to deep-level tubes, transit through which brings no change to the eye nor that variety of scene which is restful and stimulating.

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Car v. 'Bus.

SINCE our last issue the conflict around the electric car *v.* motor-'bus has waged merrily, but to the undoubted discomfiture of the adherents of the latter. To all appearances the controversy seems to be a very unequal one, as the preponderance of reliable opinion is with the "electrics," who have so many years of experience to go upon. There are very few motor-'bus systems in operation in this country, and the data which can be collected from their operation is based on such a short period of actual running that it is not fit to be advanced in support of the case for petrol traction on roads. We are all open to conviction, and also wish the merits of both sides to be considered, but the "situation" created by the halfpenny press seems too absurd to warrant serious thought; but, if a careful study is made of the arguments advanced, evidences will be found of a malignant desire to bring into ridicule the promoters of electric tramways and especially of extensions to existing lines. If the criticism came from the engineering press it would be another matter, but from the halfpenny newspaper it savours too much of interference with other people's business, and lacks weight in consequence. It was only natural that a strong rejoinder should come from the proper quarter, as perversions of vital technical questions, when freely distributed among the unthinking public, need refutation, no matter what their origin. We have rather expected Mr. J. S. Raworth to say something on the subject, unless we have overlooked any remarks of his, because his promising work with regenerative control for cars bids fair to be nipped in the bud. Regeneration, in fact, seems to us the one thing which could be thrown into the balance to make electric traction "kick the beam," were it in sore need of a champion against the motor-'bus. It would be probably the last shot in the locker, but its penetrating powers are beyond question. Though there is no need for uneasiness among tramway men for the security of their present charge, they can console themselves with the fact that regeneration will give it so extended a lease of life that when the end of its days is in sight they will not much care what happens to electric traction. It will have done its work well, and kept its end up against the best organised opposition. What is more, it will have repaid the capital expended upon it, and done a little of something else as well.

Tesla's Patents upheld.

THE discovery by Nikola Tesla of the curious property of polyphase currents for producing a rotary field resulted in the complete revolutionising of the art of power transmission by alternate currents, as a self-starting alternating current motor became at once practicable. As our readers well know, the Westinghouse Company purchased the Tesla patents, and have since exploited them with immense advantage to the electrical industry, building up that great branch of it, long-distance power transmission, which bids fair to become a factor in international affairs before very long. American makers of polyphase motors have only manufactured under license from the company owning the patents, and in one or two cases there has been trouble with those who have attempted to dodge and thus get free of the royalty. Among the famous actions instituted by the Westinghouse Company in this matter was one against the Thomson-Houston Company, for alleged infringement of Tesla's patents, but this was not proceeded with, as a patent agreement was entered into with the General Electric Company under which the latter has made and sold synchronous motors and rotary converters for several years. In suits recently brought by the Westinghouse Company against the National Electric Company and the Bullock Electric Manufacturing Company, the latter sought to defend their conduct, in making and selling synchronous motors and rotary converters, on rather novel lines. It was claimed that the separate direct-current excitation "displaced and obliterated the shifting alternating current magnetisation or Tesla whirling field of force," and that apparatus so designed did not come within the meaning of the patent specification. The learned judge, however, contended that these and similar arguments were without weight and untenable for reasons which he set forth at

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considerable length. The respective properties of Tesla's rotating field and a rotating physical magnet were, he considered, immaterial to the question at issue. The discovery and employment of the whirling field was patentable with or without direct-current excitation of the secondary element, and no such limitations as were suggested by the defendants, in this regard, could be found. The final conclusions arrived at were that the synchronous motor structure and operation of the defendants were within the generic invention patented and expressly covered by claims Nos. 381-689 and 382-281, and that the invention was utilised despite the introduction of direct-current excitation to make the action synchronous in lieu of the full realisation of the revolving field effect for self-starting. The defendants accordingly had to depart discomfited, duly enjoined from further sale of such motors and rotary converters.



Type-setting by Telegraph.

THE average engineer invariably associates high-speed telegraphy, and also writing or typing telegraphs, with a perfect nightmare of magnets and delicate mechanisms, liable at any moment to get out of order. Although such conceptions might have been in no way modified by Mr. Donald Murray's recent paper and exhibition of apparatus before the Institution, every engineer must have admired the masterly way in which a difficult problem had been grappled and so far solved as to be in effect commercially practicable. Mr. Murray's paper must rank among the best of the session, and even those carping critics who think papers on telegraphic subjects a bore could not have grudged the two evenings given up to so important a subject as that broached by Mr. Murray. Our readers will recollect our description of the type printing telegraph, which bears the same name as the author of the paper in question, published in the first issue of this journal and illustrated with photographs of the apparatus not hitherto presented in any technical publication. The Murray printer was originally conceived for operation by an ordinary typewriter of a linotype machine by means of a perforated tape. Typesetting machines of this description are in commercial use, but Mr. Murray combines his with the telegraph, and his work in this direction has met with singular success. As is explained in the paper, the problem is a mechanical one, but interwoven with it is the possibility of using electro-magnets to bring about certain operations. Mr. Murray's method has brought about a practical solution, and it remains but to persuade the great newspapers to adopt it on a more or less extensive scale. This matter is a financial one purely, and a substantial saving over present methods will of course have to be shown before proposals could be entertained for the general introduction of telegraphic type-setters. In an early issue we shall publish a special article on type-printing telegraphs from the pen of Mr. Murray himself, and we doubt not that it will be read with great interest.



America's Cable Works.

DESPITE prodigious progress in every other branch of electrical work, Americans have still a good deal to learn from the Mother Country in regard to the manufacture of electric light and power cables, and telephone cables. Mr. Darwin Bates, of the British Insulated Wire Company, the pioneer of paper insulated cables, who visited America with the Institution party, made good use of his time in seeing how "they did things" in making cables. He gives his impressions in this issue, and our readers will perhaps be surprised at the very backward state of an industry which with us has been developed to a degree almost bordering on perfection.



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The Windmill.

Operated by "DON QUIXOTE."

II. Professional Etiquette.

At the instant when the indefinite dislike of any coterie towards any individual crystallises into *tabu*, either an old rule of etiquette is raised to convict the offender or a new one is invented. Etiquette, therefore, is the formal expression of exclusiveness. Moreover, exclusiveness is the act of getting into a bomb-proof trench for the purpose of potting some other fellow in the open. It follows, therefore, that professional etiquette is an earthwork raised by those who are first in the field to repel the advance of newcomers with divergent interests. This is all very right and proper, for the noble art of self-defence has with the march of science resolved itself into a game of pop-goes-the-weasel. The question is rather, whether our earthworks are properly designed; whether, in other words, our professional etiquette is not on the whole a rather ridiculous affair. We have, for example, our Institution of Civil Engineers, and our Institution of Electrical Engineers. Any member of either of these corporate bodies who dared to insert a few display lines in the advertisement columns of the technical press would be quickly made to feel that his acquaintance considered him a low-bred bounder whose handshake was a disgrace. But he may get touching little references to his good qualities inserted in the "miscellaneous notes" of the trade journals; the description of the new works is always compiled "with the kind assistance of Mr. A. B. Cee, M.Inst.C.E., the Consulting Engineer to the Board, to whom our most grateful acknowledgments are due"; he may have as big a brass plate on his office-door as he likes, and cover half the area of his notepaper with whatever juxtaposition of letters he can lay claim to. Now if I were a consulting engineer and a man of letters (such letters being taken to mean the outward and visible sign of inward and sometimes invisible merit), I would cover the whole front of my house with lacquered brass and scribe my name and diplomas on it, so that all the world should see. Who shall speak with the voice of authority as to where a name-plate merges into a street-sign?

In the days of the *Pickwick Papers* it was permissible for an apothecary to tender medical advice, in the same way that a contracting electrical engineer may nowadays pose as a consultant. In those immortal pages Bob Sawyer, an ingenious young chemist whose weekly turnover could be "put into a wineglass and covered with a gooseberry-leaf," describes with particular glee his advertising scheme of going to divine service on Sunday morning and hiring a small boy to rush up the aisle and whisper to him distractedly. As the young doctor-chemist proceeds down the aisle with coat-tails flying, the congregation of unsophisticated persons is understood to murmur, "Bless my soul! Somebody taken suddenly ill. Sawyer, late Nockemorf, sent for. What a business that young man has!" Now, without venturing to suggest that our greater or lesser lights go to church for the object of publicity (I should immediately be confounded by the fact that some of them don't go to church at all), yet have you never heard, O Reader, when you attended a feast of reason, or partook of a feast of fat things, the letter of apology from some Professional Magnate, who at the last moment was prevented from coming "by pressure of important business"? Thus is the flank of etiquette turned. In the name of common sense, if a man has a good enough opinion of his own abilities to consider that his advice is sage enough to be run after by other engineers, why may he not frankly advertise that "A. B. Cee, M.Inst.C.E., Consulting Engineer, is THE BEST"? It would be a grand thing for the papers.

I was never much good at complex analysis, and I am willing to admit that the general relation of contractor to consultant fills me with confusion. For example, a consulting engineer, whom we will denote by Alpha, advertises in the trade papers that he is prepared to issue specifications for a piece of work to such contractors as will deposit a sum of five pounds, this sum to be returned on receipt of a *bonâ fide* tender. Very good; the unsuspecting contractor manages to borrow the fiver from a friend and exchanges it for the specification. And when he is in receipt of that precious document, he is extremely likely to find, not exactly that Gamma's engines and Beta's dynamos are baldly specified, but that such minutiæ are detailed as are covered by patents owned by Messrs. Beta or Gamma. The unsuspecting contractor, who shall be called Delta, then writes to Alpha pointing out that he can supply an engine quite as good as the one specified, with some excellent little ideas of his own worked in, at 5 per cent. under cost, for the sake of the advertisement. Alpha replies that the conditions of the specification must be adhered to; Delta writes to Messrs. Beta and Gamma, asking them to quote him for the required engine and dynamo C.I.F. Delta's works—anywhere, in fact, but on site—in the sanguine hope that Beta and Gamma are apt not up to snuff. They, however, seeing the dodge,

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quote Delta a figure giving them about 25 per cent. profit. Delta sticks on a little more to pay for his trouble, sends in his tender (with an alternative cut-price scheme including his own engines, which is not considered), in order to get his five pounds back, and learns without surprise that Messrs Gamma and Beta were rather below him in price, but had really been given the tender on account of the guaranteed excellence of their work.

Or, again, Alpha gets an inquiry involving technical points which are a little outside his weight. Being a man of business, he does not write to his client stating that he has no experience in this class of work, and that So-and-So is rather good at it. He writes instead to Beta, Gamma, and other contracting firms, and in an airy, graceful manner describes the general outlines of the scheme, telling them that they can block in the details as they like, and asking them to quote. Now Beta and Gamma have both got tame young experts who for a consideration of two or three pounds a week will coruscate to any extent. Beta and Gamma therefore hand over Alpha's letters to Phi and Epsilon, their experts, with a few easy remarks about the weather. Phi and Epsilon therefore coruscate, each in his own appointed way, and evolve schemes, redounding in drawings and alternative prices. Then they go home suffering from brain-fag. Beta and Gamma take these fruits of their labours, add a certain percentage to the price, envelop the whole with a winding-sheet of general conditions, and despatch the same to Alpha. This gentleman then selects the cheapest tender which appears to afford a reasonable probability of success, lets the work go through according to the contractor's ideas, which are generally in the direction of cheapness of production, and then writes a paper for the Institution, which makes the scheme a monument of everlasting glory to himself. Phi and Epsilon in the meantime are suffering from brain-fag, as I said before. Now, professional etiquette will not permit an advisory engineer to take a bribe, but he may eat dinners at other people's expense till dyspepsia dispenses poetic justice; but etiquette does not prevent him from employing over-educated and under-paid juniors to do the research work for which he receives the *kudos* and the pelf. In fact, the chief feature about professional etiquette appears to be its marvellous elasticity.

I would maintain further that professional etiquette is not only puzzling, but also, in some cases, pernicious. For example, at or about December 25 of each year, there is a comfortable expression of gladness on many engineers' faces, not altogether due to the joyful message that was carolled by celestial choirs, but to a convention of reciprocity known as "Christmas boxes." These, which it is quite within the limits of etiquette to give and to receive, are recognised as inculcating that friendly feeling so conducive to the placing of good orders in the ensuing year. Now there was a certain station chief who was afflicted by a conscience of the most malignant type. He was so terrifically good that he beat back all the assaults of the contractors. Yet the following story, which I tell as it was narrated to me, shows how even this good man was floored by the intricacies of etiquette.

There was one particularly bad, bold man among the contractors, who did not properly understand this chief and sent him a crisp new fiver with a most endearing note dwelling upon the happy times they had spent together, and hoping he would buy himself an ounce or two of shag to smoke continued prosperity to their contracts. With fire scintillating from his eye, the station chief returned the cheque. The bad, bold man immediately conceived that he had placed the price too low, and sent back *two* little bank-notes. Then the vials of wrath of the station chief overflowed; he sat down and wrote an epistle that would have curdled the blood of any but a bold, bad man of the very worst type. But the bold, bad man did not curdle; he gave himself over to cogitation and finally despatched the chief a third last present. And the chief arose in Jove-like anger, called a special committee meeting, put that present on the Council table, told them that bribery and corruption were rampant, and asked his committee-men what he was to do with the vile thing. And the committee-men smiled expansively and told him he could do what he liked with it. You see etiquette and ethics are not synonymous. So the chief took council with himself and sent the present of the bold, bad man to a hospital, where it was thankfully received. That last present, by-the-bye, was a big, red Dutch cheese.

Now what is the use of adhering to a system of professional etiquette which conforms neither to exigency or ethics? Why swagger along with a silver-mounted walking-cane when everybody can see one has a dirty collar? Why should we not cast aside this useless vestment of "professional etiquette" and come out bare to the buff, prepared to cut prices, best everybody, do anything that is not subject to criminal law, and without any sickly pretence at altruism honestly state that we are not running our office for the general good of humanity, but to make money for ourselves? The suggestion is Quixotic, is it not?

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SOME IMPRESSIONS NOTED ON AMERICAN WORKSHOP PRACTICE.

By DARWIN BATES, M.I.E.E.

DURING my visit to the States with the English Institution of Electrical Engineers, I took the opportunity of inspecting as many manufacturing works as was possible in the somewhat limited time, and altogether I went over about twenty works. Only three of these works were employed on cable making, and these were :

The General Electric Company, Schenectady.
The Western Electric Company, Chicago.
Roebling and Company, Trenton.

The General Electric Company and Roebling's make practically all classes of cable, with the exception of dry core telephones, whereas the Western Electric Company's Cable factory is entirely given up to telephone work.

General Electric Company.

Their cable works are not very large, and they make rubber cables as well as paper in the same building. The plant which they have in operation is, to my mind, very far from being up to date, and I did not see anything in this factory that was worth copying. In the rubber department they certainly mix their own rubber and work it up, the machinery for this purpose being old, and there was nothing approaching a labour-saving device in any way. The machines used for putting the rubber on to the cable are not at all modern—some of them only covering one wire at a time and the rubber strip being folded round the wire and cut on one side only. They therefore use a single strip of rubber to completely enclose a wire, but, of course, use two separate sheets to form the complete radial thickness on the wire. This machine covering a single wire was minded by a man and a boy. There were also a few machines in which three wires were covered at once, these being minded by two men and a boy. None of these machines run fast or turned out any better work than is the usual English practice, but their labour cost must be considerably more. The method adopted of putting these wires into a vulcanising pan seemed to me to be very crude, the pan being revolved by hand, and the wire also placed in position by hand.

On the paper-cable side of the shop they were, I think, even more behind the times. Their stranding machines were running very much slower than is our practice, without any reduction in the number of men employed in attending them, although the machines were, to all intents and purposes, the same. The paper-covering machines only had three heads of paper on a flyer, these three heads being bolted to a girder framework, and, in some cases, having a bath of the resinous compound between one three-heads and the next. A machine would have six or eight of these three-heads extending over a length of about 30 ft., and the machine being of this length necessitated a good many attendants to watch the process. The papers that were used were never wider than 1 in. or 1¼ in., and were pulled on to the cable as tight as ever they could get them. The result, of course, is that the output of the machine is very limited, and when the cable is finished the paper insulation is so tight as to almost prevent the cable from bending properly without bursting the paper.

They were in one part of their shop putting on paper which had been previously compounded, that is to say, they dried a spool of paper and compounded it before putting it on the cable. They claim for this that it saves the cost of drying and compounding after the cable is finished, and further that they get better results from a cable built in this way than from one built and dried separately, but probably the fact of their having a drier atmosphere would enable them to do this with some degree of safety. The cables were afterwards dried by an ordinary oven, and impregnated by vacuum process.

The top stories of the factory—which

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was about a four-storey building—were almost entirely devoted to braiding and cotton-covering machines, of which they had many hundreds. The great majority of the output of these machines is used in the company's own factory for dynamo work, but some is exported. A very vast business is evidently done in braided and cotton-covered wires. The braided wires have a red thread woven into the pattern, which is said to be their Trade Mark, so that they can recognise it hereafter. The braiding-machines were all New England Butt machines, or machines of a similar type, the bobbins being wound "universal wind" with a loose tooth head, and one girl took care of about twenty braiders.

The cotton-covering machines were of the New England Butt make, having the wire to be covered passing through the centre of the bobbin. They certainly run these machines at a very high speed—somewhere about 3,000 r.p.m., but as they are only able to use a small number of ends the rate of output of any head is not greater than we obtain. One girl takes care of eight heads, and I ascertained that the wages of these girls were not less than 30*s*. per week, and sometimes as high as 35*s*.

Western Electric Company, Chicago.

Having but one day in Chicago, I was only able to find time to visit one of the Western Electric factories, and naturally chose that for manufacturing telephone cables. The Telephone Cable factory is situated practically in the middle of the city, where land is dear, and consequently the factory is arranged on two or three storey buildings. Generally these buildings had flat roofs, where the drums were stored. As nearly all the telephone and telegraph business in the States is managed by companies, apparently only a few standard classes of cable are made: therefore very large stocks of wire and paper of exactly the same size and gauges can be laid in.

Curiously enough they do not cut their own paper. They buy it cut to the required width, and to the diameter of spool, so as to fit their machines. I asked why this was, and was given as the reason that they are practically always making the same class of cable and therefore do not need to keep a large number of different sizes in stock, and they find that buying the paper ready cut suits them as well as cutting it themselves.

The machines used for single insulating are horizontal machines having six heads to a frame minded by one girl or woman. The copper is put on a stationary swift at the back of the machine, and the wire passes through the centre of the paper spools in the same way as it does on our cotton-covering machines. The paper being therefore well balanced on the machine means that a high speed can be obtained, but looking at the thing off-hand I did not think the output of any individual head, as far as speed was concerned, was much, if any, greater than our own. No string is used, and at the time of my visit they were only building these wires with one paper on them.

The women running these machines are again a very much superior class of labour to that procurable in England, and they are paid 34*s*. per week. They were certainly very expert indeed, and kept their allotted number of hands almost constantly running. Their twining-machines were vertical with the bobbins side by side, but a very high speed is not obtained on these machines. They had sun and planet motion on the bobbins, and one operator had to look after only two pairing-machines.

The stranders are very similar to those we have here, but they do not run them so fast: and they use a fewer number of men on the stranders than is our practice After having loaded the machine up they seem to let the telephone cable take care of itself, they having one or two spare pairs in the cable, so that in the event of a wire getting broken or shorted during the stranding process it does not necessitate a stoppage of the machine.

After the stranding is finished, the cable is roughly tested by two operators—one tests for shorts only, and one for continuity. Girls do this testing, and are very smart with it. Having passed this preliminary test it is put into ordinary hot air ovens for drying purposes, the heat being obtained from steam pipes, and after remaining three or four days in this oven the cable is transferred to another oven behind the lead press.

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which it is intended should eventually cover this cable, and when the cable is ready for lead covering, the lead press men have themselves to get the cable out, mount it on to a swift inside the oven, and feed it into their own press.

The lead presses are worked by three men, that is to say, they do not have what we call a press driver or a man examining the cable for pin holes or defects. One of the men turns the water valve so as to admit water into the presses, and then goes behind the press and leads the cable in, and they evidently trust to luck that the lead sheathing is perfect. They only have one lead melting-pot to two presses. After the cable is lead covered it is just left standing in the shop until it is cooled off, and it is then taken without any water test to the testing-house, where great care is taken to insulate the drum from earth, whilst the capacity and insulation tests are taken, after which the cable is ready for export.

Generally speaking they do not take so much care with the cables as is the usual English practice, and the labour employed after the insulating is less than we employ, although in value I daresay it is about the same. They had some machines capable of stranding and making electric light cables, but most of these were being dismantled at the time of my visit, in order to be trans-shipped to a new factory which they have built about seven miles out of Chicago, and where they intend to move all their telephone plant, and be able, they hope, to manufacture more cheaply.

Roebling and Company, Trenton.

This was the next firm I visited of an electrical manufacturing nature, and these people are perhaps the most noted firm of wire drawers for electrical purposes in the States.

They also go in for cable making and cotton-covered and braided dynamo wires. The firm is one of pretty old standing, and they apparently fancy that what was a good method of manufacturing fifty years ago is quite suitable for the present-day requirements, and the great majority of the machines which they had for turning out wire was certainly to my mind, as far as British practice is concerned, practically obsolete. This refers chiefly to their wire-drawing department, which is contained in a five-storey building, all the wire being drawn on single blocks.

They had on the top floor one or two automatic machines, but these were running considerably slower than they could have been run, and were not drawing the wire so fine during the operation as is our practice. They are not, therefore, getting a good output from the machines, or as good a one as could have been got if they gave the matter of automatic machines better attention, but apparently they are quite satisfied to go on in the old way.

None of their machines are electrically driven, but are all driven by belts and shafting from an engine on the ground floor. The shops were very badly lighted, and there were no means of getting the material about from machine to machine on the same floor except by a rumbling truck, and as the great majority of the work was only given one hole at an individual block, the amount of handling of the copper was enormous. As a matter of fact in this place I saw just how things should not be done. I was informed that the output was eighty tons per day.

The cable-making departments were almost identical with the plant I saw at the General Electric Company's Works, that is to say, they had the same class of machines and lead presses, and also dried by hot air. The cotton-covering and braiding-departments were very large, and also very busy. For these departments also they had a five-storey building, about 100 ft. long by 50 ft. wide, which was full of cotton-covering and braiding-machines. The machinery was of the New England butt make, and similar to the General Electric Company's.

Roebling's annealing and pickling-sheds were quite as large as their wire-drawing factory, and took very nearly as many men to run them. The steel wire made, of course requires a good deal of annealing and pickling, that is to say, it has to be annealed more frequently than copper. They anneal in pots or, I should say, pipes. They get an

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ordinary 9-ft. pipe, about 2 ft. in diameter, with spigot and socket joints, block the one end up, and then fill the pipe with the coils of copper or steel. They do not make any attempt to seal the top of the pot or keep the air away from it. These pipes are then lowered into furnaces, which are sunk into the ground and fired by oil fuel. The crane stood in the centre of the annealing shop, with the pits in the ground arranged in a semi-circle round it, the operation being to lower one of these pipes into the furnace, each pipe holding perhaps five or six tons of copper. The oil fuel is then ignited and the heat got up, and when the annealing heat is attained, the gas fuel is turned off, and the pot allowed to cool in the pit.

It is difficult to know why they adopt this arrangement, as the cooling operation is necessarily very slow, and they do not get a bright wire, but have to pickle afterwards to get it clean. The wire is taken out of the pot after it is cooled, put on to a pole and dipped into the pickling-tanks, which pickle is kept boiling. The boiling of the pickle merely quickens the action, but it also makes the pickling-shed full of nasty sulphurous fumes, and generally makes a dirty mess of everything.

The tinning department was not a very large one, there being only three tinning-pans, which ran through about six wires in a pan. They do not, however, let the tin on the wire cool off in the same way as we do—by passing through the air. After passing through the tinning-bath, and being wiped, the tin is run through a bath of water for cooling purposes. This, perhaps, has the additional advantage of preventing the hot tin from oxidising, and so makes the appearance of the wire when finished rather whiter than we get it.

I went also through the galvanising shops for galvanising wire. They were using the ordinary type of galvanising-bath, and there was nothing in the shape of a labour-saving appliance.

With the exception of dozens of electric power houses, all the other works which I visited were more or less of a manufacturing nature, of which, perhaps, I need not give a detailed description.

All of these works were, of course, very instructive. I saw several rolling mills for rolling steel, brass, and copper, and in every case I found that the billet re-heating furnaces were of an automatic nature. The chief point is that the furnace is practically continuous. It is open at each end, and the cold billets are put in at one end and forced forward into the fire by means of a hydraulic ram, the cold billets continually forcing the heated billets forward at a prescribed rate of progress, which ensures that when the billet is at the required temperature it is at the exit end of the furnace, and in its turn drops over the edge of the furnace, pushing open a flat door and falling into a grooved conveyor running at right angles, which immediately starts the billet for the first pass in the rolling mills, after which, of course, the process is the same as ours.

The furnaces I saw were also all fired automatically by underfed stokers, which had the advantage of using a common sort of slack, and feeding the coal from underneath meant that any sulphur or pyrites in the coal was consumed without being allowed to pass over the metal being heated.

Taking it on the whole this American visit was a most instructive one, and the experience gained by going round the various works is, undoubtedly, very great, although perhaps one does not fully appreciate the benefits gained all at once.

Generally speaking, one did not find that the Americans were so vastly ahead of English practices as one is led to believe. There are some things, of course, that they do better than we, but, on the other hand, there are some things that we do better than they, and the use of labour-saving machinery is, I think, at the present time more largely used by up-to-date firms in England than in America. This point occurred to me very prominently from the fact that in only two, or perhaps three, of the works which I visited, had they got automatic time recorders for keeping the men's time. The majority of firms were still using the old-fashioned brass time check, which is very largely abandoned in England.

Another point was the small number of

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works which have any machines driven electrically. They are evidently only just beginning to turn their attention to this point. Even Mr. Edison's own factory at Orange is still steam-driven. He is certainly just commencing to convert into electrical drive by putting down a central station, in which the engines driving are at least twenty years old and already out of date.

There was still another point which struck me very forcibly, and that was the large number of comparatively speaking young men who seem to be at the head of affairs in these large manufacturing firms. It is a common thing to see quite a young man managing a vast concern. I suppose the old men have already made their pile and got out, but at any rate one does not see these older men taking an active interest in the business.

I mentioned this point to several Americans, and they all told me that it was a fact that men were given chances to manage large concerns very quickly in their country. They say they live so fast that a man soon gets worn out, and that it was necessary—to keep the pace—to get young and energetic men in, and although they quite appreciate that these young men probably do make some mistakes, yet, on the whole, by their energy, the balance of progress is on the right side.

Another salient feature was the fact of the very much superior class of labour they get in America to what we are able to get in England. It is true the wages are considerably higher, but on the other hand. both living and rent are higher, so that it is doubtful whether the working man is one penny better off in their country than he is here, but the labour for all that seems much more intelligent, better educated and vastly cleaner.

I also learned that it was the practice with nearly all large firms in America to send one of their representatives to England and the Continent every year. They generally tour round on this side for about two months, and by this means the firms in America keep themselves posted as to what are the latest English and Continental practices, and this certainly struck me as being a very good idea. A two months' trip does not, of course, cost a company very much money; it widens the experience of its employees, which the company get the benefit of, and I think English firms could very well afford to copy this practice with advantage to themselves.

Our Programme

for this year is full of important innovations and striking developments. We have secured the co-operation of electrical experts in all parts of the world as contributors to our columns. We have in hand means for placing our readers in touch with makers of electrical apparatus. We are doing our utmost to make this journal doubly valuable to its readers.

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Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Pelton Water-Wheel Practice.

Puyallup River Water Power Development (U.S.A.).



At the time the order was placed for Pelton water-wheel apparatus for this installation there were no tangential wheels in operation anywhere in the world driving anything larger than a 2,000-kw. generator. The problem presented for this plant was to equip the initial installation with four direct-connected units each driving a 3,500-kw. General Electric generator at 225 revolutions per minute, the water-wheels to operate under an effective head of 865 ft. Also two Pelton exciter water-wheels, each driving a 150-kw. exciter at 600 revolutions per minute. The topography of the ground on which the power house was to be located was such as to make it necessary to maintain a minimum width of building, otherwise the amount of excavation necessary would have been enormously expensive.

The ultimate installation is to consist of eight units, and the entire equipment is so arranged as to provide complete pilot control of the water-wheel apparatus as well as the electric. This is accomplished from the switchboard which is arranged at one end of the building, and the complete eight units, the ultimate proposed capacity, will require a building length considerably over 200 ft. long. It was therefore necessary to keep down the length of each unit as much as possible, and for this reason, among others, it was decided to employ the Pelton two-bearing double wheel overhung type of construction. This was arranged with one water-wheel on each end of the main shaft, this construction enabling the bearings to be more equally loaded than if the entire output was placed on one water-wheel. The fractional load efficiency is also better, and the regulation very much closer than would be obtained if a single nozzle and wheel were employed to develop the entire output for each unit.

The contract with the Pelton Water Wheel Company for the hydraulic equipment commenced at the terminals of the four main pipe lines and that of the exciter line, and the supply for each of the eight Pelton water-wheels is furnished through a twenty-four-inch cast-steel specially designed gate valve, as illustrated in Fig. 1.

The main bodies of these gates are located below the floor line, the yoke and gearing projecting well above to enable the gates to be readily operated by hand from the main floor if necessary. Suitable gearing is arranged so that the gate may be started on its seat under the full working pressure by an auxiliary hand wheel, shown in the illustration. An electric motor control with suitable switching mechanism from the main switchboard is also provided for operating the valve. There is mounted on the main gate stem a cut-out to enable the motor to automatically cut-out at each end of the stroke without interfering with the return connections, and the motor being reversed the cut-out is again automatically closed. The deflecting nozzles are of very substantial proportions, having twenty-four-inch inside diameter inlet flanges and tapering slightly to the tips. The ball joint is polished and provided with sole leather packing. The trunnion pins are each set in oil-packed phosphor bronze bushings and are of fluid compressed nickel steel turned and polished. Supports are provided on each

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end of the trunnion pins, one end setting in an axial recess in the ball and the other end supported by a heavy forged steel strap. This is securely keyed and bolted to the body of the nozzle. The swinging portion of the nozzle weighs approximately 5,000 pounds, and is counterbalanced by a suitable bronze lined controlling hydraulic cylinder with leather-packed piston receiving pressure from the main pipe. The nozzle tip is flanged and bolted to the terminal of the nozzle taper pipe, and turned true and polished on the inside surface to curves of least resistance. The needle itself is cast hollow and of gun-metal, and turned true and polished to make the smoothest possible surface over which the water flows. Fig. 2 shows the character of stream obtained from one of these nozzles. This photo also clearly shows the blur occasioned by the rotating wheel centre and buckets during the exposure of the photographic plate.

The needle is threaded to the end of a heavy nickel steel rod, which is carried in a suitable grease-packed bushing and is supplied with bronze bushed bearings. The water pressure against the needle is balanced by helical steel springs, which may be adjusted to the different sizes of tips or to wear. The position of the needle may be readily adjusted by a hand wheel actuating cut gears and forged steel connections to the needle stem.

It will be noticed that the power developed on each wheel may be controlled in two different ways :

(1) By deflecting the nozzle, thus varying the quantity of water which impinges on the wheel ; and

(2) By varying the flow of water through the nozzle by adjusting the position of the needle above mentioned.

The hydraulic governor is arranged for controlling the speed automatically by moving the deflecting end of the nozzles. It will be noticed that this in no way varies the velocity of water-flow in the main-pipe line, and therefore cannot possibly occasion any water hammer. This is a point of the utmost importance in obtaining accurate regulation, especially under high pressures and when using long pipe lines. This form of regulation is much superior to that obtainable with turbine wheels for this very reason.

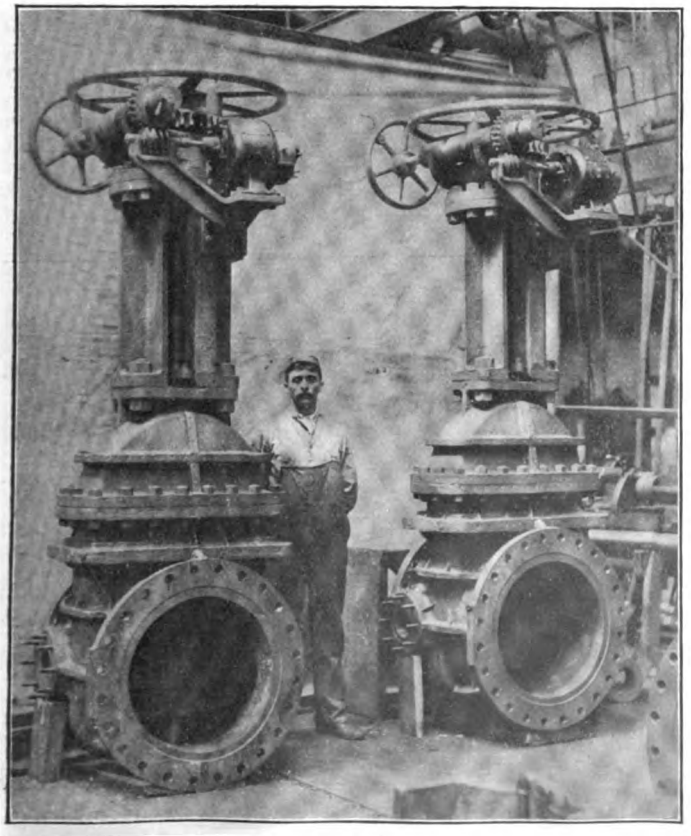


FIG. 1.—CAST-STEEL MOTOR WATER WHEEL-GATES, WITH QUICK AND SLOW MOTION GEARING AND AUXILIARY MOTOR DRIVE

The Pelton wheels (Fig. 3), two in number for each unit, are pressed one on each overhanging end of the nickel steel shaft. These are 9 ft. 10 in. in diameter and each wheel is fitted with a set of cast-steel annealed Pelton buckets ground to true interior surfaces and milled and drilled to United States standard gauges to fit the rim of the main cast-steel wheel centre. Buckets and centres are carefully adjusted to an exact weight and to a running balance, and each bucket is securely bolted to the wheel-rim with two fluid-compressed nickel steel bolts provided with hexagon semi-finished nuts. The buckets are spot-faced where the nuts seat upon them, and all milling and drilling and reaming is done to United States standard gauges and jigs.

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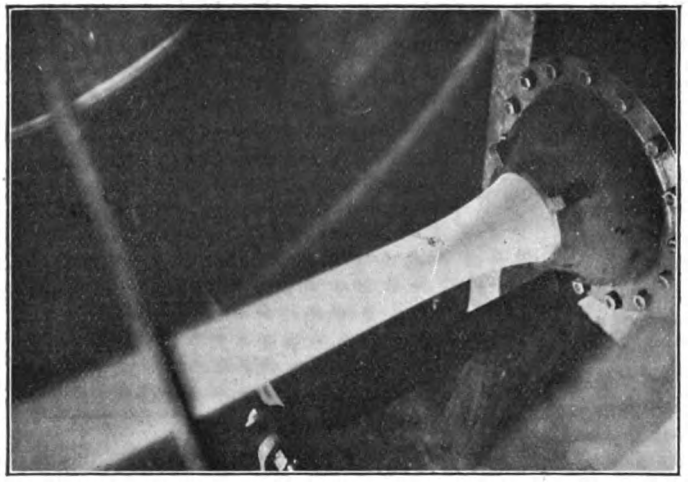


FIG. 2.—NEEDLE NOZZLE STREAM. SHOWING THE STREAM OF WATER FROM A PELTON NEEDLE REGULATING NOZZLE.

The main shaft for each unit is made from highest grade fluid-compressed nickel steel, forged hollow, annealed and bored out. The shaft is turned to 14 in. in diameter at each end and to 20 in. in diameter where fitted with the generator rotor between the journals. The bearings (Fig. 4) are of Pelton generator type, with heavy machined ball and socket joints, and provided with Finn's armature metal, bored out and scraped, and each supplied with four heavy bronze rings. In addition to this, special oil grooves are cut in both the top and bottom halves of the bearing, which are further doweled together. There is a special high-pressure oil groove not connecting with any of the others. This is located vertically under the axis of the shaft, and connection is made to this by flexible high-pressure oil pipe from a motor-driven high-pressure oil pump supplying pressure-oil at 2,000 pounds per square inch. It is only necessary to use this pump in starting the wheels in order to avoid damaging the babbitt surface, as the rotating element weighs in excess of 98,000 pounds. So nicely is the entire rotor balanced that a man's weight on one of the buckets will readily turn the entire shaft when the high-pressure oil is turned on. In addition to this, there is provided a centrifugal oil circulating system so that the bearings may be flooded with a large additional amount of cool oil if the least heating occurs. There is also a set of water-cooling connections arranged to a grilled water compartment next to the babbitt surface, so that a maximum amount of heat may be removed by the cooling water. In each bearing a pair of thermostats is connected in parallel in a suitable electric circuit for indicating at the switchboard a dangerous temperature rise in any of the journal bearings.

The highest grade of material and best possible machine work was furnished throughout this plant, which has now been in operation for some time. No shut down of any kind has been occasioned by the hydraulic apparatus, although each unit is guaranteed to operate at 7,500 h.p., and has in practice carried loads in excess of that amount. The plant is operated twenty-four hours per day, and the entire project has been carried through to a successful

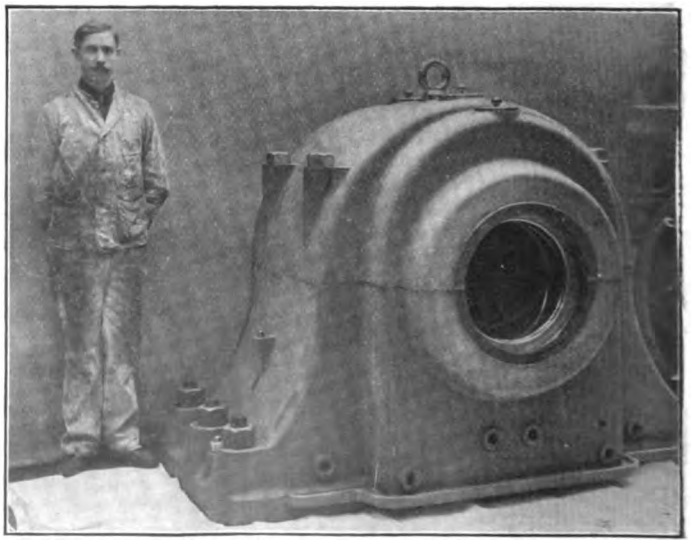


FIG. 4.—GENERATOR TYPE BEARING WITH MACHINED BALL AND SOCKET JOINT, WATER COOLED, AND WITH CENTRIFUGAL AND HIGH-PRESSURE OIL CIRCULATION. DESIGNED FOR CARRYING WEIGHT OF 66,500 POUNDS AT 225 REVOLUTIONS PER MINUTE

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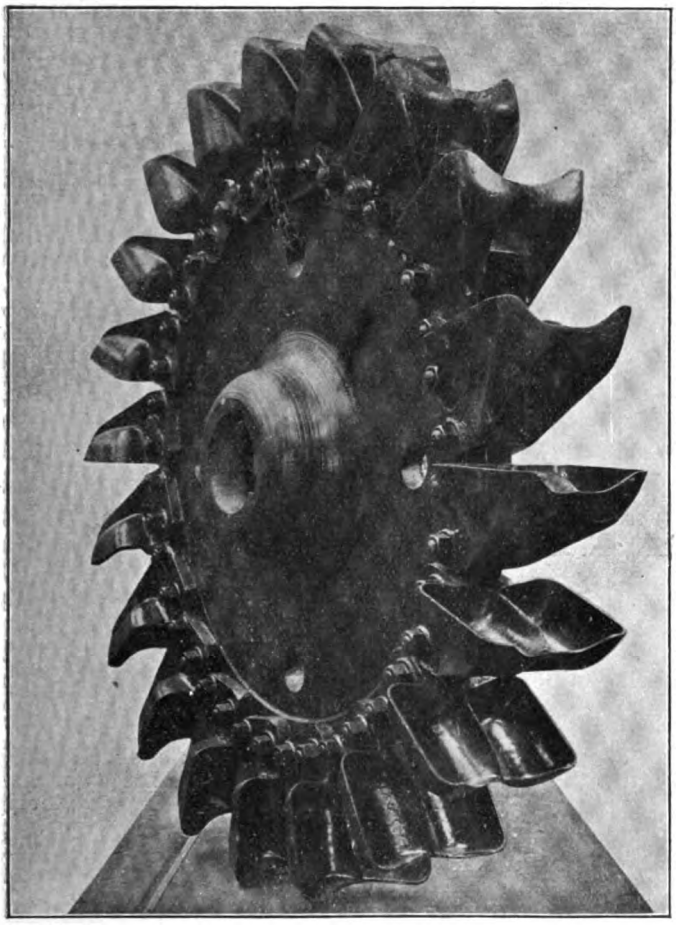


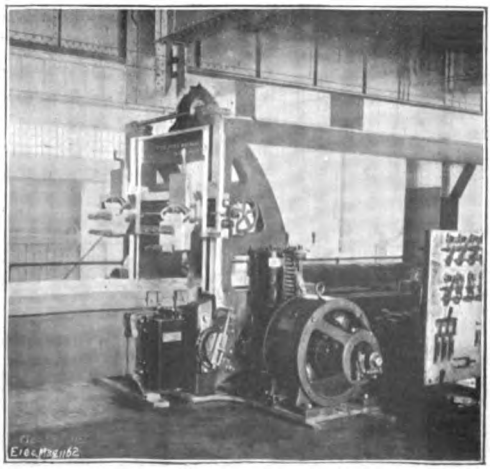
FIG. 3.—ONE OF THE MAIN PELTON WHEELS. THERE ARE TWO OF THESE FOR EACH UNIT, EACH WEIGHING OVER 14,000 POUNDS AND ONE PRESSED ON TO EACH END OF THE NICKEL STEEL SHAFT.

issue in the remarkably short period of sixteen months, the first water-wheel unit being put in continuous operation in exactly one year from the signing of contract.

Variable Speed Motor Drive for Planers.

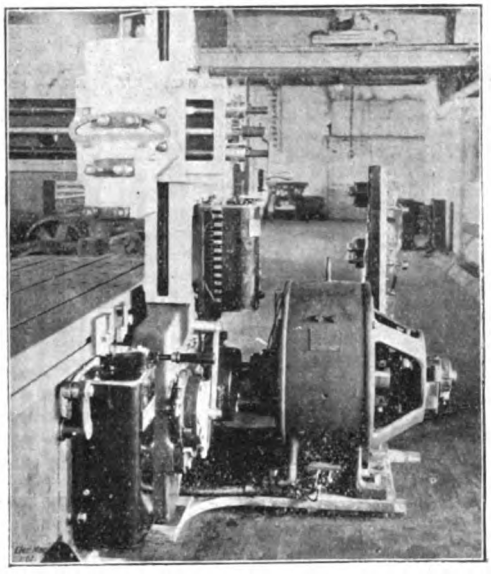
THE Electric Controller and Supply Company have developed a direct-connected motor-drive which gives a number of cutting speeds, and these are instantly available by a simple operation of the controller. By this means the cutting speed may be instantly and accurately adjusted for securing maximum cutting efficiency with any material to be worked. The planer is direct-driven with a variable speed motor without the use of belts or clutches, the motor being, wherever possible, directly coupled to the cross shaft of the planer. By means of a reversing switch, operated by dogs adjustably mounted on the platen of the planer, and an automatic controller, the motion of the driving-motor is reversed at either end of the stroke. An operating controller is provided, by means of which the speed of the motor in the cut-cutting direction, may be accurately regulated. The automatic controller is so arranged that on the cutting motion at each stroke, the table on the planer will be automatically accelerated to a speed determined by the operating controller, and, on the return, the table will in general be accelerated to maximum speed, as it is, of course, desirable that the table be returned as rapidly as possible on the idle stroke.

Where desirable, however, as in the case of planers which cut in both directions, the controller may be so arranged that the speed in either direction may be varied at will. The operation of the controller is such that the driving motor will reverse and accelerate the platen



CONTROLLER, MOTOR, AND PLANER.

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MOTOR AND PLANER, SHOWING REVERSING MOTION.

of the planer just as rapidly as is consistent with the power of the motor. The maximum current which can flow to the motor is absolutely limited, so that there is no sparking or undue mechanical straining at the instant of reversal. The platen may be reversed by hand through the operation of a shifter attached to the reversing switch. When the shifter is brought to the central position the platen is instantly stopped. The operating controller is provided with a notched dial which plainly shows the cutting speed, and the automatic controller requires no attention whatever from the operator.

Planers equipped with this form of drive have thoroughly demonstrated, not only the practicability of the system, but also its very pronounced advantages in increased output of the tool, superior accuracy of stroke, low cost of maintenance, simplicity and compactness.

Variable Speed Induction Motors.

THE present methods for regulating the speed of asynchronous motors can hardly be considered satisfactory. Resistances in the rotor circuit are not economical, and Ganz's cascade method, though ingenious, has numerous drawbacks. A system lately put in practice by the Oerlikon Company of Zurich consists in varying the number of stator poles, the rotor being of the ordinary squirrel-cage type. For this purpose there are two windings on the stator, one of which has two four-groups of coils or sections per phase, which may be connected so as to form four poles in series, four poles in two parallel circuits, or eight poles as required. The second winding provides in a similar manner for six or twelve poles. Motors of this type are claimed to be specially suited for driving lathes and other machine tools, requiring to be operated at varying speeds. A comparison of results obtained with these two windings at no load and full load shows: First, that current values at no load are practically the same with the smaller number of poles (four and six) or with twice that number (eight and twelve), if parallel connections as mentioned above be adopted, but if the poles are in series then doubling the number of poles increases the no-load current to four times its former value; secondly, that doubling the number of poles brings no modification of current value at full load in the case of series connection, while this value becomes four times less with parallel connections. From this it follows that where a constant power is wanted parallel connections need not be considered. This applies more specially to the driving of machine tools requiring a pretty large torque at comparatively small speeds. On the other hand, the same parallel connection is very useful in cases requiring a constant torque, and motors driving pumps, ventilators, hoisting apparatus, &c., would come under this heading. Thus, motors provided with these two windings are equally suitable for developing



OERLIKON VARIABLE SPEED INDUCTION MOTOR

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constant power or constant torque at varying speeds.

The following table relates to a triphase motor of the type described, the constant power being taken equal to 15 h.p. and the constant torques 10 to 20 kilogrammetres.

FOUR-SPEED TRIPHASE MOTOR.

	Connection.	Revs.	Amperes.	η.	cos ϕ.	Torque kgm.
Constant Power 15 h.p.	4 poles parallel	1475	18	86.0	0.84	7.3
	4 poles series	1445	15.5	86.0	0.935	7.5
	6 poles parallel	975	20.5	85.5	0.72	10.8
	6 poles series	920	17.1	84.0	0.915	11.5
	8 poles	715	19.2	84.0	0.79	15.0
	12 poles	447	23.0	77.0	0.77	24.0

Constant Torque.	Connection.	Revs.	Amperes.	η.	cos ϕ.	H.P.
10.0 kgm.	4 poles parallel	1470	23.0	88.0	0.90	21.0
	2 poles series	1425	21.0	86.0	0.92	20.0
	6 poles parallel	980	20.0	84.0	0.69	13.6
	6 poles series	933	15.0	85.0	0.915	13.2
	8 poles	727	14.5	82.0	0.69	10.0
	12 poles	455	12.5	76.5	0.55	6.0
20.0 kgm.	4 poles parallel	1430	43.0	90.5	0.94	39
	4 poles series	—	—	—	—	—
	6 poles parallel	960	31.0	88.0	0.85	26.8
	6 poles series	830	31.0	72.0	0.80	23.4
	8 poles	700	25.5	82.0	0.82	20.0
	12 poles	410	24.5	78.0	0.73	12.7

The method also endows the motors with good starting qualities, as shown below :

Connections.	Torque (kgm.).	Amps.
4 poles, parallel . .	36 ..	260
4 poles, series . .	9 ..	68
6 poles, parallel . .	65 ..	245
6 poles, series . .	14 ..	65
8 poles . . .	18 ..	82
12 poles . . .	30 ..	70

If you are interested in Electric Power matters, let us hear from you. We may be able to do you a service.



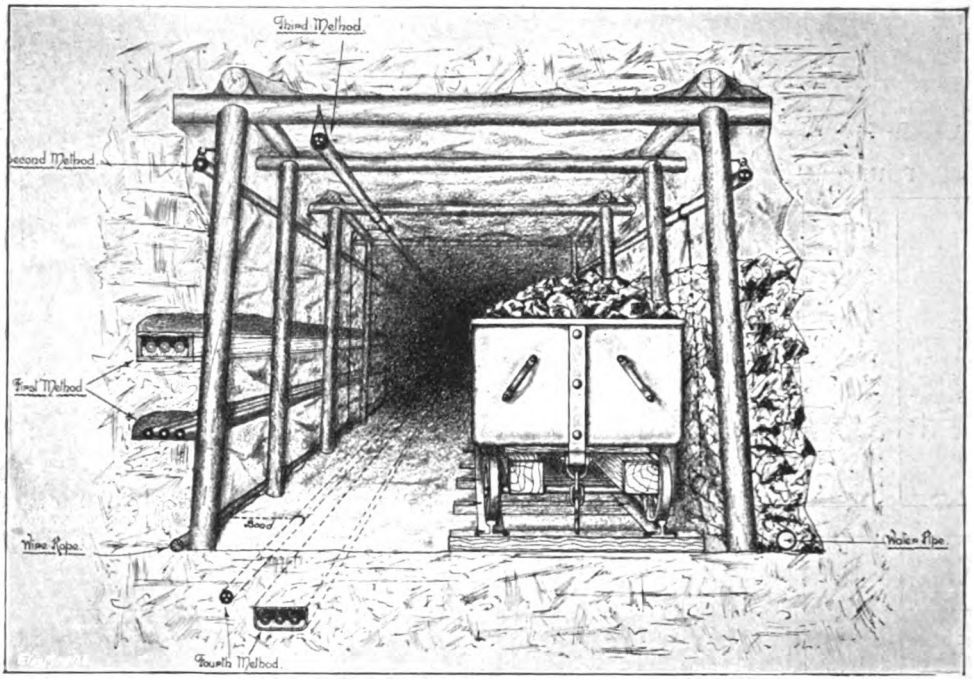
INDUCTION MOTOR AND CONTROLLER COMPLETE.

HORSFALL DESTRUCTOR AT BROMLEY, KENT.

THIS destructor, in which the fires were lighted on October 25, 1904, presents many points of special interest. There are now in existence three destructors in which the refuse is tipped directly from the carts into the destructor cell, without any intermediate handling or expenditure of labour whatever. These are all erected by the Horsfall Destructor Co., Ltd., and are situated at Shot Tower Wharf in the City of Westminster, at Blackpool, and at Bromley. The destructor at the Shot Tower Wharf was the first on this principle and the Bromley plant is the most recent, and consequently it contains considerable improvements in detail over the first. The tipping floor at Bromley is approached either by an inclined road or by a steam-driven hoist, which raises the horse and cart to the upper level. On the tipping platform the cart is backed up to the feed hole of one of the three furnaces, the charging door is opened, and hopper lowered into its place, and the cart tips its load bodily into the furnace. The charging door is then closed and the cart taken away. The whole of the above operations occupy less than half a minute. The door when closed dips all round into a water seal on the Horsfall Company's patent, which prevents the escape of smoke and dust, and also prevents the door from being burnt out.

Each cell is capable of burning from ten to fifteen tons of refuse per twenty-four hours.

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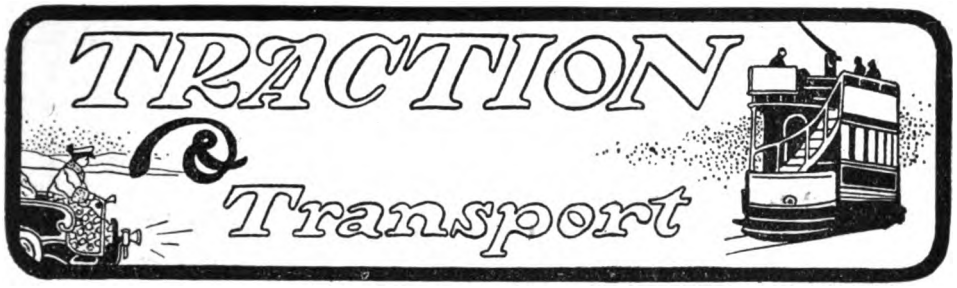
VIEW OF MAIN ROAD IN A COAL-MINE, SHOWING VARIOUS METHODS OF RUNNING POWER CABLES.

The hot gases pass out from the destructor and are thoroughly mixed in a large combustion chamber contained within the furnace block before passing to a Babcock and Wilcox boiler of 250 h.p. The flues are carefully designed and built, and between the boiler and the chimney is a patent centrifugal dust-catcher of the improved "Accrington" type. This consists of a circular chamber in which the gases are given a swirling motion, causing the dust to be driven by centrifugal force through a narrow opening into the cleaning pit at the outside of the dust-catcher. The arrangement has been proved capable of catching over 98 per cent. of the dust contained in flue gases. The chimney is 120 ft. in height, of hexagon form, rising from a square base.

COLLIERY POWER CABLES.

WITH the extent and use of electricity in collieries comes the necessity for method in running the necessary cables, and more especially in the workings. Not infrequently the leads have been thrown about indiscriminately, with the consequent risk of damage to the cables and also of fire. The above illustration is taken from a new catalogue on Colliery Cables issued by the St. Helens Cable Company, and clearly illustrates the various ways in which conductors can be laid along the main roads of a colliery. Referring to the diagram the first method consists of single unarmoured cables either laid on a shelf or in a trough filled in solid. In the second method unarmoured leads are suspended behind the troughs with tarred twine. In the third method armoured cables are used and suspended either from the roof timbers or in front of the troughs. This is not recommended, but it is cheap and easy to erect. In the fourth method armoured cables are laid direct in the floor or unarmoured in troughing laid solid. Of the above the first has been found superior to any other as in addition to being simple it is quite safe. Systematic cable laying is evidently as essential in collieries as on the surface, and should receive careful attention at the hands of colliery proprietors installing electric power plant in the workings. Equally important are the methods of carrying large cables down the shafts of the mine. One of these is to place three separate conductors in wood casing fixed firmly to the shaft, this latter being pierced at its upper end to allow the leads to pass underground to the power house. Another method entails the use of a three-core cable to which is fitted a special gripping device carrying chains which are fastened into the brickwork of the shaft.

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A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

America's First One-Phase Railway.

By MERCURIUS.



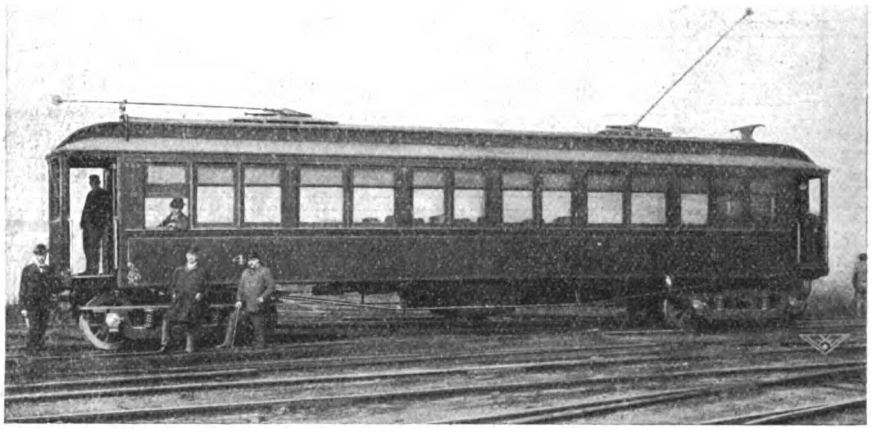
To the Westinghouse Electric and Manufacturing Company belongs the credit of getting into operation the first one-phase electric railway in America. Our contemporaries across the water have been full of the details of this system, and it is certainly of sufficient interest to merit notice on our part. Readers will have read Mr. Mordey's reference (vol. ii., No. 1) to the system employed so that we can spare them unnecessary minutiæ of the apparatus. Mr. Mordey mentioned the line on which the system has just been inaugurated —that of the Indianapolis and Cincinnati Traction Co.—in the article already referred to. The company in question was formed to build and operate the line, and, at present, forty-one miles of track have been laid between Indianapolis and Rushville, between which places a through service was established on January 21. Sharp curves have been avoided and a private right of way has been secured for the track; except where it passes through important towns *en route*. Between cities only single track has been laid, the double line existing at stopping-places. A 70-lb. rail is used bonded with No. 4-0 10 in. copper bonds with $\frac{7}{8}$-in. terminals under the plates. The suspension is quite novel and entirely unlike ordinary traction practice. As may be imagined considerable care was needed to support a bare conductor overhead for trolley operation at 3,300 volts, but the method adopted is both ingenious and adequate. Extending from the supporting cedar pole is a special bracket of angle iron having a loop into which a large porcelain insulator is dropped, this insulator having a groove in its top into which the supporting wire is fitted. This wire is of $\frac{7}{16}$ in. steel strand, and is termed the messenger wire.

From it at 10-ft. intervals depend steel clamps which hold up the trolley-wire, this latter being of No. 3-0 grooved copper. The steel messenger wire is drawn taut and with the catenary suspension a practically level trolley-wire is obtained. There are, also, no sudden bends at the insulators, and should one of these break the messenger wire is still supported by the bracket. The height of the trolley above the rail is 18 ft. In streets and populous districts the trolley is suspended on span-wires, the construction being otherwise the same.

System of Supply.

From the power house at Rushville, energy is supplied at 33,000 volts one-phase, 25 cycles and reduced at transforming station ten to twelve miles apart to 3,300 for use on the trolley-wire. Three sub-stations have, at present, been built and equipped with static transformers only. The stations measure 21 ft. by 23 ft. and are of fire-proof construction throughout. There are two floors, the lower for the transformers—of which there are two oil cooled of 300 kw. each —and the upper for the lightning arresters and line switches. No automatic devices of any kind are used, and the

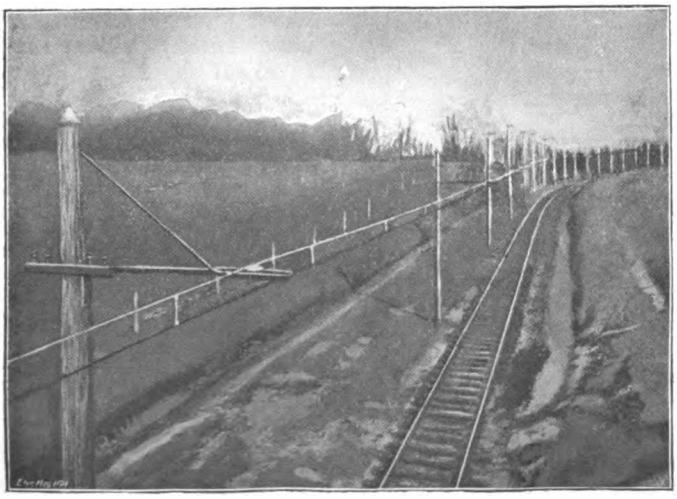
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Car Fitted with One-Phase Motors.

station is locked and left unattended. It is estimated that at least $6 a day is saved per sub-station by the absence of rotary converters. For the railway system in question the total economy secured on this score is £4,400 per annum.

The power line carrying the 33,000 volt leads runs beside the track on a separate set of poles. No. 4 bare copper wires are used two wires to each sub-station, and the supporting points are large porcelain insulators on iron pins. A complete circuit is made at the sub-stations, leaving all controlling switches at the power house in charge of the attendant there.



Suspension for Overhead High-Tension Trolley-Wire.

The Power House.

This is a fire-proof building of brick, and comprises the usual boiler house and engine-room. The former contains three 300-h.p. Babcock and Wilcox boilers which are fixed with natural gas—this being by no means an unusual feature—but provision is made to burn coal when the supply of gas is deficient.

The engines, two in number, are horizontal Corliss type each of 700 h.p., and are coupled to 300-kw. three-phase 25 cycle generators of Westinghouse make.

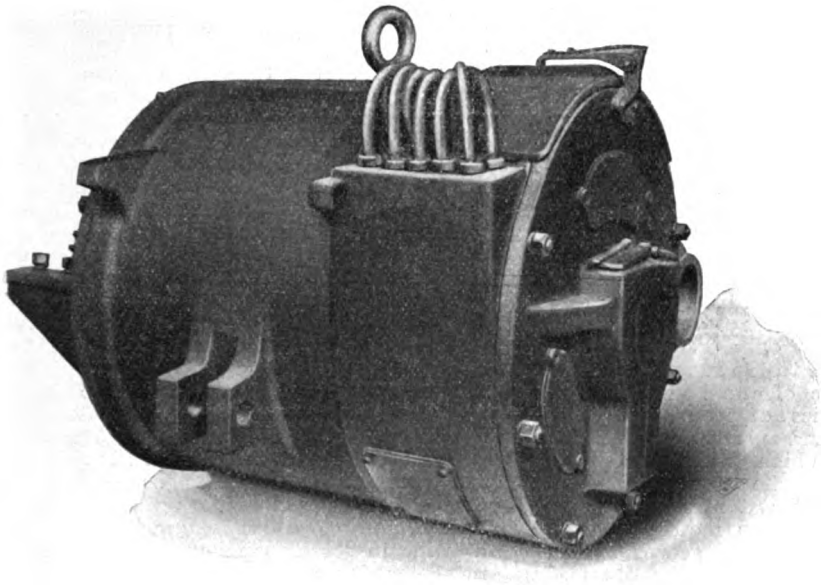
Current is generated at 2,300 volts, and transformed to 33,000 volts two-phase four wire by the Scott method, being then distributed to the sub-stations as one-phase current two wire.

Rolling-Stock and Equipment.

The equipment at present comprises ten passenger cars, each 55 ft. over all, and divided into three compartments, one for luggage, one for smoking, and the other for passengers. The total seating capacity is fifty-four passengers.

There are two 75-h.p. motors on each track, the rheostatic method of control being used with

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GENERAL VIEW OF ONE-PHASE MOTOR AS USED ON INDIANAPOLIS AND CINCINNATI LINE.

multiple unit turret switches. The motors can be operated by either direct or alternate currents, the former being supplied from the local lines in the terminal cities. A trolley-wheel is used on these lines, but the high voltage stretches are run over with a special form of bow collector. The motors are geared to give a maximum speed of forty-five miles per hour, but thirty miles per hour is the schedule speed. Higher power cars equipped with four 150-h.p. motors to give a schedule speed of fifty or sixty miles per hour will shortly be put into service. When this express service is put on it is expected to complete the journey between Indianapolis and Cincinnati in three hours from centre to centre of the respective places.

Fares.

An average fare of 1½ cents per mile is charged by the company for carrying passengers, the road being divided into five-cent sections; no fare less than five cents is charged for any ride. A school-children's ticket is issued, good for use one hour before or after school hours. A mileage or sectional ticket is also issued at a reduced rate, giving 160 five-cent. rides for seven dollars, a reduction of 12 per cent. from the ordinary fare. No other tickets are sold and cash fares are collected on the car.

The entire scheme is a most creditable performance, and reflects well on the enterprise of the Westinghouse Company.

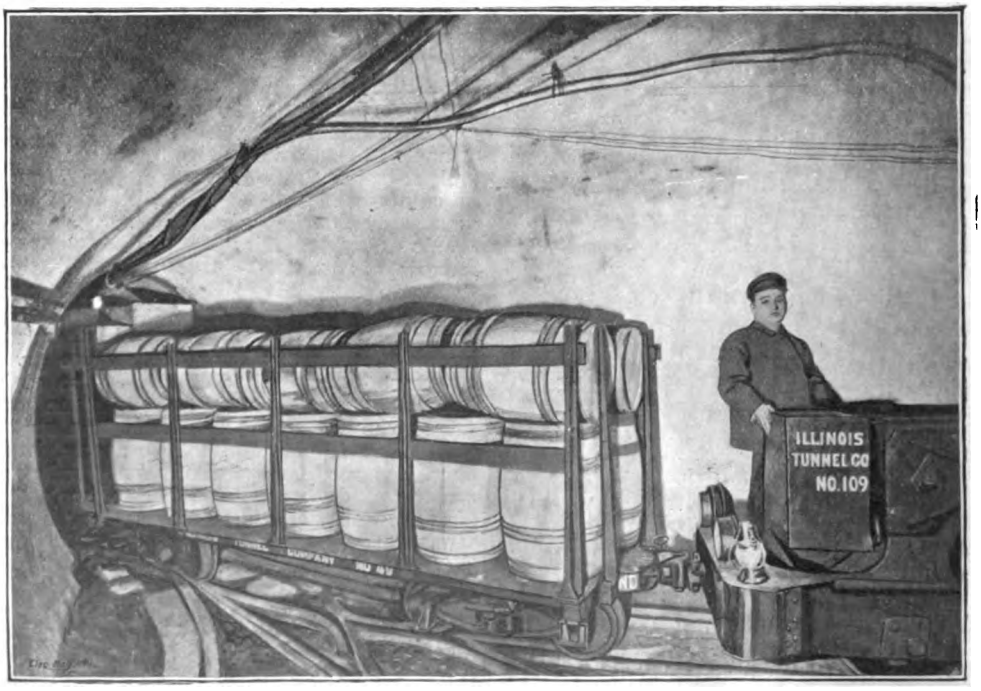
Freight Traffic Underground.

WHILE London is being burrowed with tubes to carry passenger-trains, a portion of Chicago is being honeycombed, but at a shallower depth, with tunnels to accommodate small electric freight-trains. The business area of Chicago is compressed into a space about a mile square, and an enormous mass of passenger traffic and "teaming" goes on within this narrow compass. The cost of the latter traffic to the great railway termini in 1903 was £10,000,000, and some 30,000 teams are now in use. Restrictions of weather and business exigencies limit the service given by these transporting companies to eight hours daily and business expansion has driven the entire system almost to a standstill. The Illinois Tunnel Company, however, has recently opened twenty miles of underground track beneath the congested districts and will give a twenty-four hours' service daily with its electric locomotives and rolling-stock. The tunnels themselves are of concrete, horse-shoe shaped, and their tops are about 30 ft. below the surface. They follow the routes of the principal streets above them. The track is a No. 56 rail on a concrete bed with cast-iron chairs, but without ties. Two types

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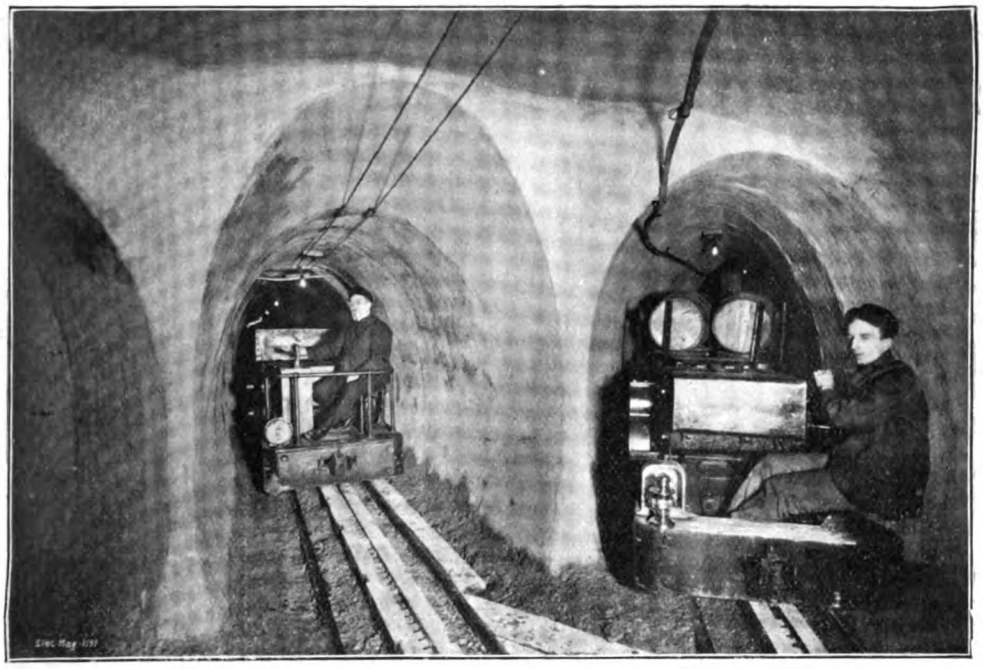
of locomotive are employed, one operating from a trolley wire supported from the tunnel roof, and another collecting current from a rack laid centrally between the running rails, this rack also serving to assist the locomotives up steep grades to the surface. Both these types can be seen in the adjoining illustrations. Each type has a capacity of 1,200 pounds draw bar pull at six miles per hour, and weigh approximately 6,000 pounds for the rack type, and 9,000 pounds for the trolley type. The rails are used as return conductors and direct-current is supplied at 250 volts. The rack locomotives have only one motor which is suitably geared to the rack-wheel, placed under the centre of the body. The rack comprises a series of iron bars coupled by fish-plates and partly covered by a wooden casing which prevents accidental contact with it. The trolley locomotives are similar to standard mining types, and are equipped with two motors, placed in tandem on the truck and geared by single reduction gear to the axles, the motors being operated by the usual tramcar type controller.

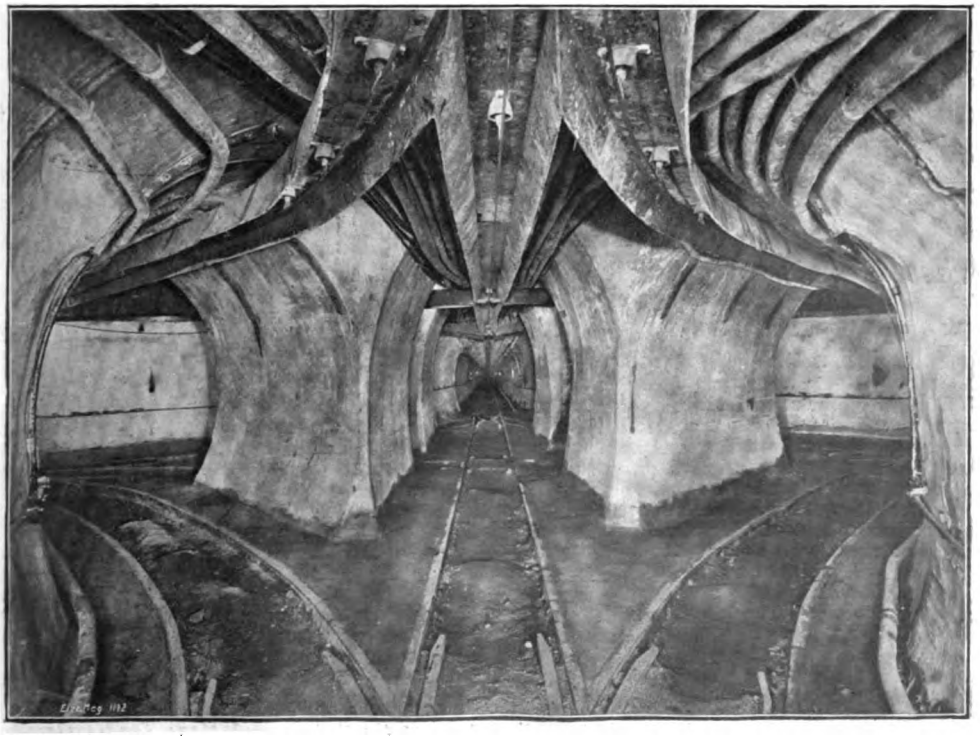
The system is being developed to handle the bulk of the heavy and light freight traffic of the business area of the city, but at present is dealing with the earth from the foundations of new buildings being sunk close to the tunnels. A quantity of this is run out to dumping-grounds on the shores of Lake Michigan. In numerous cases elevator shafts have been sunk to the floor level of the tunnels, and the empty cars are run on the elevator and taken to the surface for loading, being afterwards lowered for transport. A large traffic is expected in coal, of which some ten to twelve million tons are delivered annually into Chicago. This is all surface hauled by horses, and the complaints are many of the discomforts inflicted on pedestrians by its passage through the streets. In the same way the refuse is also carted, and the nuisance in this case can be better imagined than described. Again, the roar and din of the traffic, occasioned by 100,000 tons of freight passing over cobbled roads, must be appalling enough to need silencing as effectively and speedily as possible. This will, of course, be done by the tunnel system when it gets into full working order. The scheme is an engineering feat claiming universal approbation, and one which may well be taken as a guide in solving similar traffic problems in other large cities. We are indebted to the kindness of Mr. Samuel Insull, President of the Chicago Edison Company, for the photos reproduced. It is interesting to note that the scheme was developed from powers originally granted to what is now the Tunnel Company, to construct a cable subway under a portion of Chicago for running telephone leads.



TROLLEY LOCOMOTIVE HAULING FREIGHT-WAGGON IN CHICAGO TUNNELS.

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TWO VIEWS OF THE TUNNELS. THE UPPER ONE SHOWS THE RACK LOCOMOTIVES IN USE, AND THE LOWER ONE THE TROLLEY LINES AND THE TUNNEL CONSTRUCTION.

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Pacific Coast Water Powers for Electric Railroads.

THE Use of Pacific Coast Water Powers in the Electrical Operation of Railroads" was the title of a comprehensive and interesting paper read by Mr. Robert McF. Doble, before the Pacific Coast Railway Club on January 21, in San Francisco. Under the advantages of a central power station, the author spoke of the present-day limitations of the steam station and of the possibilities of obtaining power from hydroelectric plants. Particular reference was made to the conditions on the Pacific coast, where available water powers are distributed at frequent intervals all the way from Southern California up into British Columbia. Only a very small portion of these water powers has been developed, even with the stations now operating and the transmission systems now carrying power throughout the central portion of the state, and the conditions would seem to make profitable the operation of at least some of the railroads by electricity. In such a system of distribution as is possible in California, considerable power might be generated by trains descending mountain divisions and thus fed back and utilised in the distribution network. Reference was made to the saving in the cost and maintenance of track, the possible increase in capacity of existing railroads, the saving of time and labour in the operation of an electric locomotive, its characteristic simplicity and the rapidity with which repairs can be made. The relative reliability of the steam and electric plant was held to be in favour of the latter, especially in consideration of the local conditions in California, where a number of water-power plants feeding into the same distribution system would make exceedingly remote the possibility of breakdown of anything more than an individual locomotive, and the chances for that were only half those for the steam locomotive. Turning to the achievements of electric traction in California, particular reference was made to the Los Angeles and Redondo Railway, the Pacific Electric Railway of Los Angeles, and the North Shore and Key Route systems of San Francisco. The North Shore Railroad is of special interest by reason of its being the first and only third-rail line in California, and because of its being operated from a sub-station which is the terminus of one of the longest transmission lines in the country. The Alto station referred to is 180 miles from the hydroelectric plant at Colgate and 250 miles from the new De Sabla power house. As to projected electric lines on the Pacific coast, reference was made to improvements which the Southern Pacific Company has under consideration for its suburban lines in Oakland, Berkeley, and Alameda, to the rumoured electrification of that company's San Jose and Port Costa lines and also to the possibility of operating its mountainous divisions by electricity. Mr. Doble concluded with some very interesting remarks on the leading hydroelectric power stations and transmission systems of California.

Press Opinions of the Souvenir Issue.

The two excerpts appended herewith, selected at random from a host of other eulogistic references, will interest our readers.

"One of the finest and most interesting productions dealing with matters electrical is the souvenir number of THE ELECTRICAL MAGAZINE (1s.). The number is descriptive of the tour of the Institution of Electrical Engineers in America, the editor (Mr. Theo. Feilden) with graphic pen describing the tour of five and a half weeks from start to return. Apart from his intensely interesting descriptive matter, the magazine is crammed with photographs, probably the most interesting being those depicting the reception of the party by T. A. Edison. The souvenir, in short, is of so unique a character that it is not surprising that a second edition was rendered necessary immediately upon publication."—From *Northampton Evening Telegraph.*

Reflects the opinions of hundreds of other papers.

"The special shilling number of THE ELECTRICAL MAGAZINE is something more than an American Tour record. It contains from 150 to 200 pages of special matter, presenting the best ideas and opinions of experts. The whole is embellished with many exceptional and unique illustrations reproduced from photographs specially taken by Mr. Theo. Feilden and Members of the Institution of Electrical Engineers on the recent tour. The subjects illustrated embrace views of the cities, streets, waterways, institutions, power houses, electric plants, &c., of America and Canada. Some of the engravings of units, details of machinery, &c., will be of special importance."

From the "Book and News Trades Gazette," the leading organ of the publishing world.

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Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

ON THE ELECTRICAL MANUFACTURE OF LIGHT AND THE LAMP OF THE FUTURE.

By J. A. FLEMING, M.A., D.Sc., F.R.S.

(Professor of Electrical Engineering in University College, London.)



By far the largest portion of the immense capital invested in electrical undertakings is, at present, represented by plant created for the electrical manufacture of light. There are, at present, some 320 or 330 electric lighting stations for public electric supply in the United Kingdom alone, and the probable equivalent lamp connection of all these stations was twenty-two million 8-c.p. lamps at the end of 1904. As the annual increase is now about 25 per cent. there will probably be twenty-five million electric glow-lamps (reckoned in 8 c.p.) in use in Great Britain at the end of 1905. We have then, in addition, an immense and not easily computed amount of arc lighting. When we consider not merely the United Kingdom, but the world at large, and remember how electric lighting has extended in countries like Switzerland where water power is cheap, and in the United States and other countries where coal gas is dear, we see that the total number of incandescent lamps in use in the world cannot fall far short of several hundred millions.

When we ask what is the cost of production of light by this means and why it is so high, we are led to consider some old but still unsolved problems. There is hardly any transformation of energy which is so lamentably inefficient as the transformation of electric current energy into the energy represented by the small range of eye-affecting radiation. It is well known that at least 90 per cent. of the power spent in an arc lamp and 95 per cent. of that spent in an incandescent lamp produces no useful effect at all as far as vision is concerned. The chain of transforming devices used to convert the potential energy of coal and oxygen at one end, into the energy of radiation of required intensity with wave length lying between 0.43μ and 0.75μ (μ = .001 millimetre) at the other end, is extraordinarily inconsistent in efficiency. We put to credit, so to speak, 1,000,000 energy units in coal and oxygen in the boiler house, we get out 100,000 units in the engine, and say, 80,000 or 90,000 at the switchboard and 70,000 or 80,000 delivered to the lamp, and then the energy transformation process drops in effectiveness to a ridiculous value and we take out some absurd little amount of 4,000 energy

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units in the form of rays which can stimulate the human retina, or a gross overall efficiency of 0.4 per cent. or at most 0.8 per cent. for arc lighting.

When we consider the very great ability that has been brought to bear upon dynamo design and engine invention and the high level which these arts have reached, it seems as if such labours were, in a sense, thrown away whilst the final process to which all the rest contribute in the manufacture of light remains so utterly unsatisfactory from an engineering point of view. Moreover, our knowledge as to the precise value of the energy transformation which does take place in the passage from electric current to luminous radiation is very imperfect. The whole subject of light production is immensely important from an engineering point of view, because there is no such field for improvement open in any other portion of our energy transforming devices. Assume that there are all the equivalent of 4,000,000 8-c.p. electric glow-lamps in nightly use in London used to stimulate the retinas of 4,000,000 inhabitants. Then the power expenditure represented simply by the useful radiation is 6,000 kilowatts, whilst the actual power expenditure is 120,000 kilowatts, at least assuming the lamps at any one moment all in use.

This does not agree with the estimate made by a scientist who thought that "a little boy turning a handle" could light all London if his power could be exclusively applied in useful light ray production, but it represents an extremely wasteful energy transformation. Remembering that the coal used to produce light by our electrical means was originally primeval vegetation built up by the action of solar rays, we see that the release of the "bottled sunshine" contained in the steadily diminishing supplies of British coal is a process which is uneconomical in the highest degree. As a mere preliminary to a careful study of the problem we need a reformation in our nomenclature and modes of reckoning the efficiency of electric lamps as well as some more precise and scientific method of defining what it is we produce.

First as to standards of comparison. The practical standard of illuminating power adopted by the gas Referees in Great Britain is the Harcourt Pentane Lamp. In Germany, it is the Hefner Amyl-Acetate Lamp. It has been shown, however, that these flame standards are greatly affected by variations in the amount of moisture in the air, the barometric pressure and the carbonic dioxide present, and that the two former factors may affect the light-giving power to the extent of 4 per cent. The writer of this article, many years ago, commenced observations and experiments, which resulted in the production of a special form of large bulb carbon filament incandescent lamp as a Photometric Standard Lamp. This lamp when prepared according to a specification of the author and used in a certain way has been found to be an exceedingly constant standard of light. It is not affected by moisture in the air, change of pressure or temperature, and is therefore superior to a flame standard. The light emitted by it depends only upon the electromotive force applied to its terminals

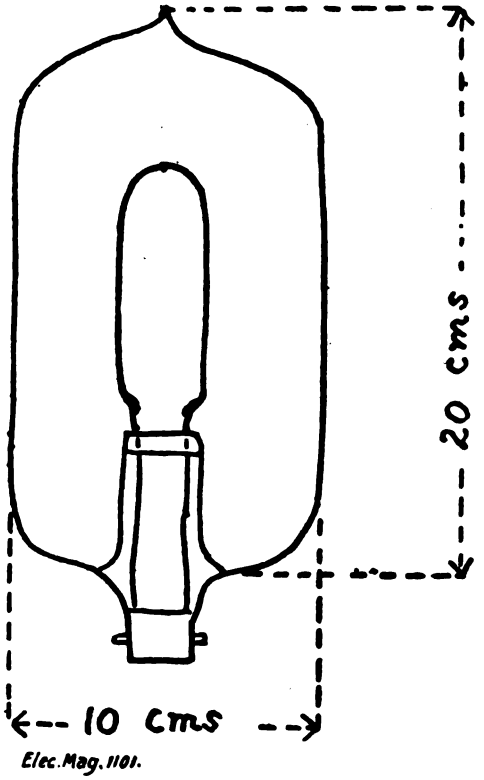


FIG. 1.

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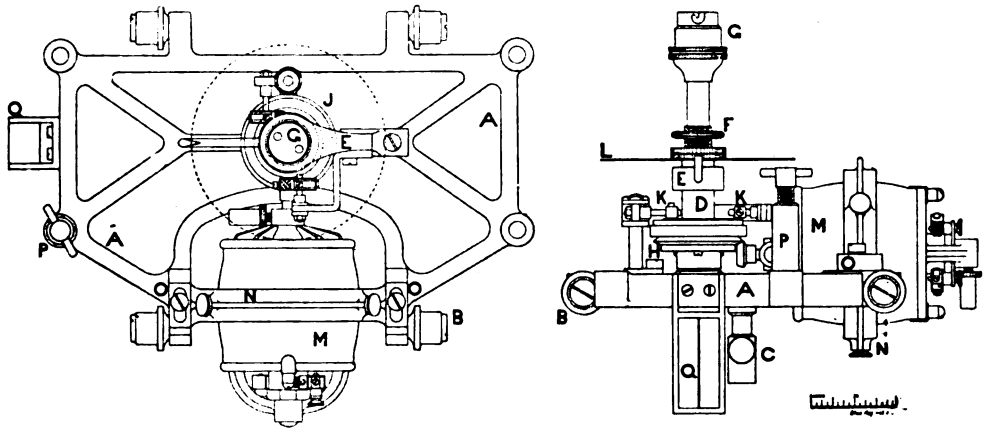


FIG. 2.

and this can be measured with great exactness by a potentiometer. When the lamp is thus set at a certain voltage it will have a certain marked illuminating power. The lamp does not blacken in use, and remains constant for years together if used in a certain way. In Fig. 1 is shown one of these large Bulb Photometric Standard Lamps as made by the Edison and Swan United Electric Light Company. These standard lamps have been in use for years in the Pender Electrical Laboratory with great success and have recently been used by the National Physical Laboratory.

The next question is as to measurements. The common custom of measuring the so-called "candle-power" of an incandescent lamp in one direction, viz.: a horizontal one when the axis of the lamp is vertical, is insufficient. The lamp emits light of different intensity in different directions and the important question is the determination of the total flux of light from the source. This can be readily obtained by an Integrating Photometer. In the Pender Electric Laboratory at University College, London, such a photometer was constructed some time ago, and it is probable that it is the only one of this type in use in London. It is constructed on a plan suggested by Mr. C. P. Matthews with certain modifications in detail, and it gives by one single observation the total flux of light from an incandescent or arc lamp, or any other source. The glow-lamp is placed in a socket carried on a spindle which can be set in rotation by a small motor so that the lamp revolves four or five times a second around its vertical axis. In Fig. 2 is shown a general view of this rotator. The lamp so carried is placed in the centre of a semi-circular metal and wood disc, which carries on its circumference twelve pairs of mirrors so placed that the light proceeding from the lamp in twelve equi-spaced directions is reflected through holes in the disc and converged to a point exactly opposite the lamp but on the other side of the disc (*see* Fig. 3). Here it is received on the screen of a Lummer-Brodhun prism photometer, and the screen is illuminated by the sum of all these separate radial illuminations. This illumination is balanced against one horizontal ray taken from the same lamp, and the result is to enable us to obtain the ratio between the total flux of light from the lamp, or, as it is called, the "mean spherical candle-power" and the "mean horizontal intensity." For details of the calculations and the instrument, the reader must be referred to a Paper recently read before the Physical Society by Mr. G. B. Dyke, B.Sc. (see *Phil. Mag.* for January 1905), who conducted experiments with the instrument in the author's laboratory.

One of the important results obtained by Mr. Dyke was that for widely different types of incandescent lamps there is a fixed relation between the total flux of light from the lamp and the illuminating power in a horizontal direction when the lamp is spinning round its vertical axis,

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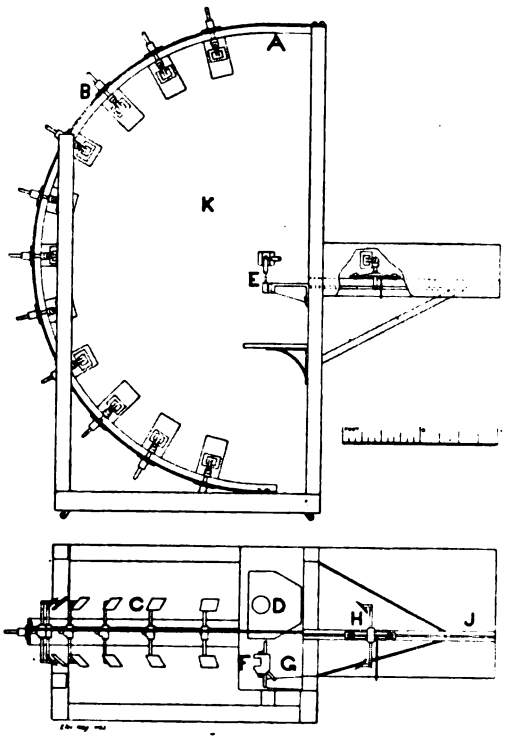


FIG. 3.

in other words, the total flux can be obtained by multiplying the "mean horizontal candle-power" by a constant which is nearly 0.78. Hence it is quite a simple matter with this photometer to obtain the total flux of light from any source provided the illumination is symmetrical with respect to a vertical axis as can be made so by rotating the lamp.* The important figure or coefficient in fixing the illuminating value of an electric lamp is that number which gives us the total power expressed in watts which must be expended in the lamp to produce a total flux of light equal to that of a certain standard. This is a very different thing from the so-called "watts per candle" to which lamp manufacturers cling as an expression of the value of their lamp or which is always given as a proof of what the lamp is worth. Moreover, some more careful definition is necessary as to the *quality* of the flux of light emitted. All light is not the same kind of light, and just as the expression "one pound of meat" taken alone is no criterion of its edible and digestive value, for it may be tough or tainted, so we require to define more carefully what we mean by a unit flux of light.

If we form a spectrum of white light and select certain rays we find they are not all of equal value for visional purposes. In a beam of light the rays of various refrangibilities have different brightness, and a curve can be obtained (*see* Fig. 4) showing by its ordinates the relative brightness of the rays in the spectrum. Moreover, for the purposes of "seeing" objects, the rays lying in the middle of the spectrum are most useful, and if we take a source of light emitting a radiation rich in the more refrangible rays at the violet end of the spectrum, we may cut away a large portion of this more refrangible light without greatly reducing the visual value of the illumination. For probably nine-tenths of the purposes for which we require light, we can get on just as well with a source of light which emits only rays lying between the bright red and greenish blue of the spectrum or between wave lengths 0.65μ to 0.45μ as with one emitting more refrangible rays.

This is seen in every case in which there are "flame" arc lamps outside shops in contiguity to ordinary open or closed arc lamps. The rich yellow or golden light of the flame arc lamps and its large radiant surface seems to show up

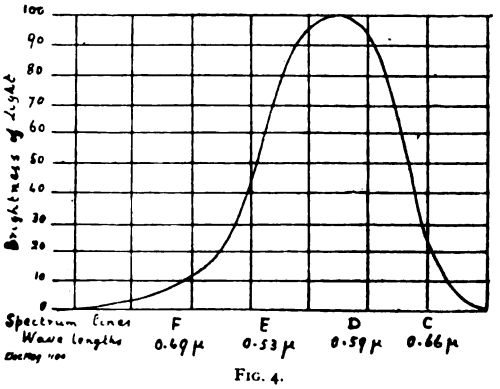


FIG. 4.

* More recent experiments in the Pender Electric Laboratory have shown that for a Nernst lamp this factor is on 0.51. This is very important, because it shows that although the so-called "watts per candle" of a Nernst lamp measured in the direction perpendicular to the glower rod may be as low as 1.5, yet the total flux of light from a Nernst per watt expended is not so much greater than the total flux of light per watt expended for a carbon filament lamp.

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objects far better than the white arc with its concentrated light, rich in violet and blue rays.

To "see" well the retina must be stimulated by a certain power applied to it per square millimetre, and this must reach it in the form of rays having a certain wave length and amplitude. The true method of comparing sources of light would, therefore, be to express the power in watts represented by the useful range of wave lengths emitted at the required intensity for comfortable vision. Hence a bolometric method of measurement, the radiation being filtered through a screen which would cut off all the non-essential radiation, would be the best method. It is, as often pointed out, absurd to estimate an arc light in "candle power." No number of candles, however great, are the equivalent of an electric arc. When we compare in this manner the total useful luminous flux, the advantages claimed for certain forms of lamp are not always supported by facts.

Experience shows that the maximum comfortable illumination which will enable us to see objects such as printed letters on a white surface is that known as *one candle-foot*. If we imagine a glow-lamp giving light in every direction equal to that called ten-candle-power, placed in the centre of a sphere of one metre radius, a normal eye could easily read small print on white paper on the inside surface of this sphere. The energy expended in such a lamp would be about forty watts, and two watts would be the power expended in purely luminous radiation. The surface of the sphere would be nearly 12.25 square metres or nearly 120 square feet.

Since two joules = nearly $1\frac{1}{2}$ foot-pounds, we arrive at this result, that to see objects well necessitates the expenditure of 1 foot-pound per second of energy per 80 square feet of surface, this energy taking the form of luminous radiation with wave length lying between 0.45μ and 0.65μ.

The fact that we require for "light" æthereal vibrations lying between such narrow limits of frequency suggests at once that it must eventually be done by making some substance phosphoresce intensely, by striking or bombarding it with electrons. A large number of useful lights are produced by intensely heating some refractory oxide or earthy material. We have the lime-light produced by intensely heating a cylinder of lime by non-luminous oxyhydrogen jet; the Welsbach burner produced by heating a mantle impregnated with or consisting of Thoria, Ceria, and other earthy oxides, by a non-luminous air gas flame; the Nernst lamp consisting in a glower made of Yttria, Zirconia, and Ceria or other similar oxides, heated electrically; the flame arc lamp in which a refractory fire-clay or other radiator is heated by contact with an electric arc, and various forms of electric arc lamp in which the arc is made to heat intensely a lime or marble or magnesia block. The modern electronic theory of electricity and matter has, as one of its deductions, the conclusion the æther waves can only be created by the vibrations of electrons; and it is only these point-charges of electricity that are nimble enough to vibrate at a rate which will create "light." Hence light is not the effect of motions of atoms as a whole, but only of the motions of electrons which compose these atoms. The electronic vibrations can exist without any necessity for the motions of the atoms as a whole. The creation of light, therefore, by the process of setting up violent atomic movements or vibrations is a clumsy expedient for bringing about these far more rapid vibrations of the electrons, which, to the number of hundreds or thousands, build up the atoms of gravitational matter.

The researches of Sir James Dewar have shown that reducing the temperature of many substances to that of liquid air greatly increases their phosphorescing power. Hence unquestionably the ultimate method of producing so-called artificial light will be by some way of exciting intense phosphorescence. Sir William Crookes' well-known experiment of exciting brilliant phosphoresence in rubies by bombarding them with the cathode discharge in a high vacuum gives us very suggestive ideas.

I therefore picture to myself the lamp of the future something as follows:

In a highly exhausted bulb will be placed a small sphere of some substance, I know not what, which phosphoresces intensely under electronic bombardment. On either side and slightly above this ball

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will be a pair of metal saucer-shaped discs which will be connected by sealed-in platinum wires with the terminals of the lamp. To these will be supplied, in some way, a high-frequency alternating current which will create a storm of bombarding electrons and the phosphorescent mass will glow intensely with a brilliant white light but a perfectly cold light. The lamp will give what we call 16 candle-power with an energy absorption of 5 or 10 watts instead of 50 or 60, and will emit no radiation except that which can affect the eye.

I am not able to provide details or to say how these high-frequency currents will be generated, or the present form of wiring utilised. I only give reins to the imagination in looking forward to discover the ideal form of illumination. Invention has necessarily to move slowly when once large capital is invested in one particular form of manufacture. Long before the stage of phosphorescent lighting is reached we shall, no doubt, pass through other stages of thermal lighting, by which is meant the process of producing light by heating some material.

In mere efficiency a very great advance has been made in the various forms of Mercury-Vapour lamp. In these a column of mercury vapour is the material heated, and its radiation efficiency is five or six times that of a carbon filament lamp, as it is only about 0.1 watt per candle. Unfortunately, the radiation is so wanting in red rays that the resulting light is not adapted for many purposes of illumination. The practical problem of adding the necessary red light to make the resultant light fairly white is attracting careful attention, and we may any day find the mercury vapour lamp presenting itself in a form which will bring it into the arena of practical employment.

Returning then to the question of electric arc-lighting, it may be mentioned that experiments have been in progress for some time past in the Pender Electric Laboratory at University College, London, which have had for their object to determine the relation between the total flux of light from arcs of various lengths with various carbons and the power spent in the arc, when supplied either as continuous or as alternating current. These experiments have shown so far that the

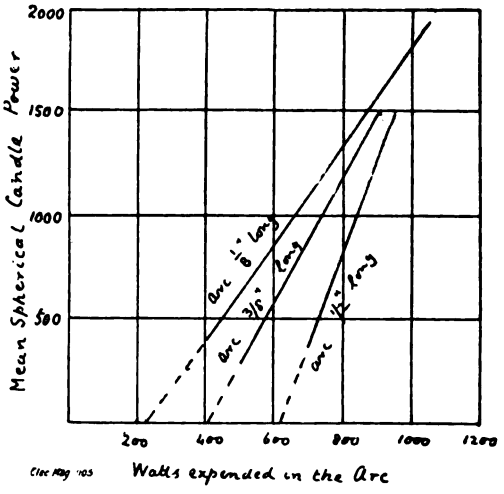


FIG. 5.

total flux of light as measured by the Integrating Photometer when plotted in terms of the power supplied in watts gives a nearly straight line. This line, however, does not pass through the origin but in front of it, so as to show that the total flux of light from the arc is proportional to the watts supplied over and above constant quantity.

The relation is generally as shown by the lines in Fig. 5. There is a constant amount of power in each case for each length of arc which must be supplied before any flux of light occurs at all, and then with increasing power supply the total flux is proportional to the power supplied above and beyond this constant quantity. This suggests that the latter represent the power required to volatilise the carbon required to maintain the arc. These experiments are still in progress at University College, London, and the writer believes that when completed and published they will afford much useful information concerning the energy efficiency of arc lamps with various lengths of arc, both alternating and continuous, as well as the most economical arc lengths for working with various currents. The immense labour involved hitherto in measuring the total flux of light from an arc lamp has prevented this information being readily obtained, but the means are now at hand for obtaining it, and rapidly valuating any form of light-producing agent.

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Making a British Glow-Lamp.

FROM a pretty laboratory experiment the manufacture of the electric glow-lamp has become a matter savouring rather of commercial integrity than of scientific achievement. This may appear on the surface to be a strange deduction, but a little careful reasoning will prove its correctness in every detail. The lamp itself is the product of a number of processes which individually are simple enough, but which collectively give an element of uncertainty to the quality of the finished product. In plain English, out of every hundred lamps made thirty are below the standard of the remaining seventy, and in a well-conducted establishment should be thrown out as unfit for the market. In the eyes of the manufacturer who works in the interest of the consumer of electric light, this 30 per cent. of wasters must on no account be allowed among his normal stock of good lamps. Here then is the factor which characterises glow-lamp making as a matter for commercial integrity. The question must be viewed entirely from the consumer's standpoint. The electrical engineer undertakes to furnish him with a reliable electric lamp, and in his authority alone will he repose confidence. In the industrial field competition intrudes almost as a natural consequence and changes the entire aspect of the situation. The various makers all adopt practically identical processes of manufacture, but in the strenuous rush for orders some are unscrupulous enough to take advantage of the wastage above referred to, to cut prices by marketing cheap and nasty lamps.

Foreign Competition.

Our foreign competitors in this branch of electrical work are the greatest offenders, and it is against them that we wish to inveigh in introducing to our readers the subject of this article. Under the present circumstances a customer of the industry he supports suffers for the conjuring tricks of a few manufacturers who might just as well "play the game." We should not have written in this strain had we been writing on the making of dynamos, motors, engines, or turbines, because in these instances the consumer knows what he gets for his money, and if he does not can easily find out for himself. In the making of any of these apparatus there is little or no uncertainty as to the efficiency or reliability of the complete produce, that is, of course, within well-defined limits. They are all the result of formulæ or processes which admit of little divergence from a fixed standpoint in development. With the glow-lamp, however, just the opposite is the case. The problem is well defined, but between its postulation and solution are functions tending always to production of widely varying results.

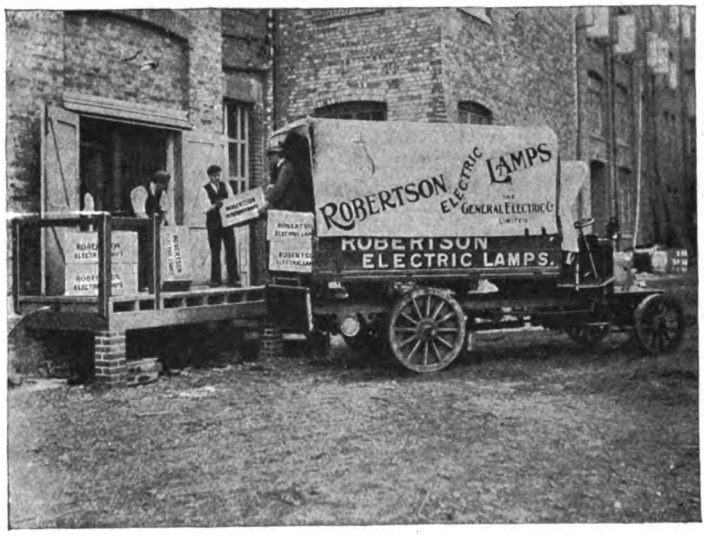
Brook Green Lamp Works.

We make the above remarks by way of preface to a short account of a recent visit we were privileged to make to the Brook Green Lamp Works of the General Electric Co., where the famous "Robertson lamps" of that company are daily manufactured in their thousands. A large and flourishing factory is there in active operation under the best possible



EASTBOURNE PIER AT NIGHT, LIGHTED BY "ROBERTSON" LAMPS.

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LOADING UP "ROBERTSON" LAMPS IN MOTOR VAN FOR TOWN DELIVERY.

conditions as regards the *employees*, whose welfare is safeguarded in every conceivable manner. As there are a large number of women engaged, greater care and propriety is needed than with men only, but from what we saw everything possible had been done to secure comfort in working, and the conduction of work with due decorum. Some 600 hands are employed and the present output of the works is about 18,000 lamps per day. The various processes were inspected by the party which we accompanied through the factory with the greatest interest, and in each case it was felt that nothing had been left undone to bring the works up to date.

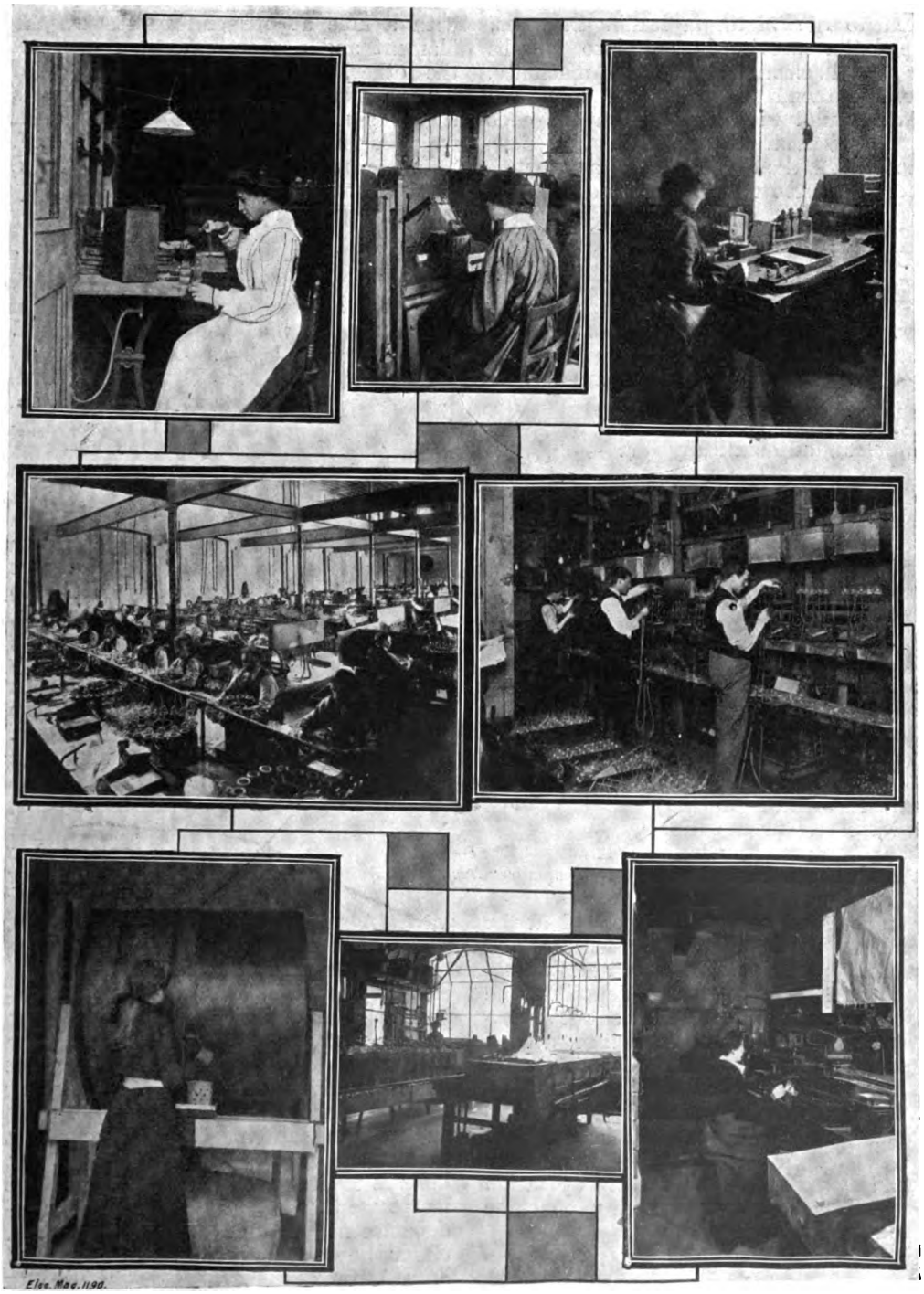
Making the Filament.

A solution of cellulose now generally forms the material adopted for the carbon filament. In the case of the "Robertson" lamp, cotton wool is dissolved in a solution of zinc chloride, this being forced under air pressure through dies into an alcohol solution in which it is formed into a semi-solid gelatinous thread; it is subsequently washed after treatment in chemical baths and dried on the surface of a large steam-heated drum upon which it is carefully wound. After drying it has the appearance of catgut, and is sufficiently tough to be wound on suitable carbon blocks, and thus prepared for carbonising. Small machines are used for this purpose to expedite the process as much as possible. These carbon blocks to the number of a couple of dozen are then packed in plumbago pots and covered with carbon powder to exclude all outside air. In this state the blocks are gradually heated up to a very high temperature which is maintained within close limits for upwards of thirty hours. When removed from the furnace the thread is found to be perfectly carbonised, and in this state is very elastic and almost as hard as a diamond. After being gauged with micrometer gauges, the filaments are



AFTER HOURS AT THE "ROBERTSON" LAMP WORKS.
(This large room has been set aside by the Directors to enable the employees to hold weekly concerts, entertainments, dances, etc.)

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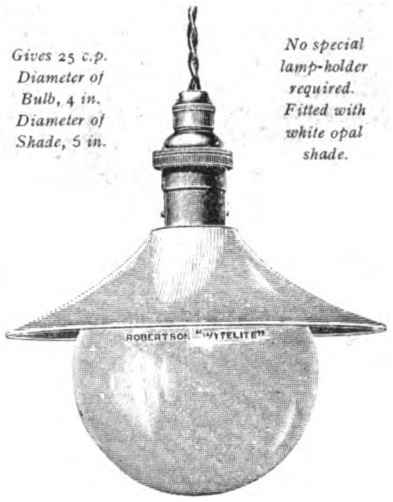
Winding the Filament. *Attaching Filament to Platinum Leads.* *Flashing the Filament.*
Blowing Glass Bulbs. *Exhausting the Bulbs.*
Drying the Filament. *Squirting the Filament.* *Photometric Tests of Complete Lamp.*

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fixed to the platinum leading-in wires, the latter previously cut into lengths by small electrically driven machines, have one end flattened and converted into a small tube, into which the ends of the filament are inserted. The next operation is the depositing of hard carbon over the juncture of the wire and filament.

Fitting Platinum Leads.

The filament and platinum wires are so placed between clips that a current can be passed through the two junctions by way of a short-circuiting piece which cuts out the greater length of the filament. The clips are then dipped into a container of liquid hydrocarbon (benzine) and current is automatically switched on. The heat generated at the joints between the filament and platinum causes the deposition of the carbon from the benzine at these points, and the junction is thus securely made. The filament is then flashed by being placed under a glass bell from which all air is exhausted. The bell is then filled with hydrocarbon vapour, and a powerful current is passed through the filament. This is heated to a high degree of incandescence, and carbon is deposited at the thinnest parts of the filament, which naturally become hottest and consequently receive a greater deposit. The final resistance of the filament is ascertained on a Wheatstone bridge with a zero galvanometer. The filament, after being finally checked and examined by other operators, is connected with two copper leading-in wires and sealed into a short length of glass tube for convenience in handling. This sealing operation is performed on a revolving machine attended by two girls.



ROBERTSON "WYTELITE" LAMP.

The Glass Bulbs.

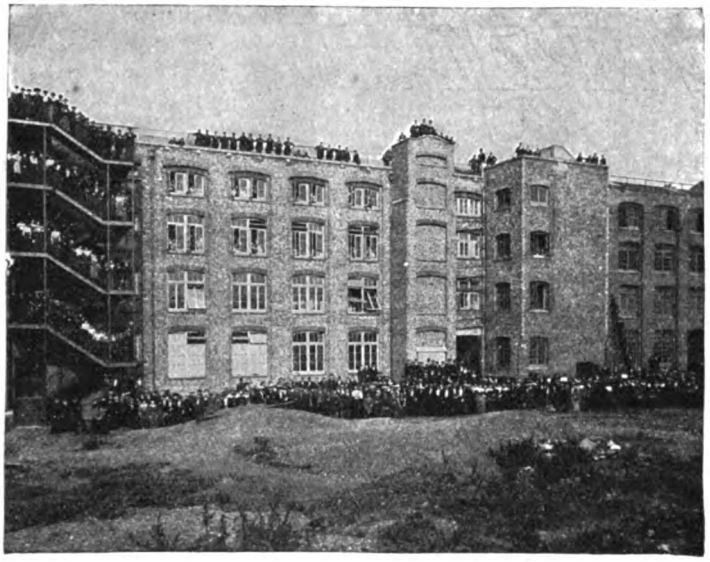
In the glass-blowing department a large number of men are engaged in blowing the lamp bulbs. These are blown with a hole at one end to receive the filament and a short extension piece at the other, which is subsequently used for exhaustion purposes. The filament is then inserted in its small glass holder which is finally fused into the bulb itself. This operation is also performed on a revolving stand, which admits of the very rapid handling of the various parts.

Exhausting the Air.

The lamp is now ready for exhaustion, and after another careful examination is passed on to the pumping-department. Here a number of mechanical air pumps are coupled to various lengths of tube, which admit of the stem of the bulb being hermetically joined to them. The tubes are in groups of five to a fork, one fork being coupled to a single pump. Fully 99 per cent. of the air is extracted from the bulb by the mechanical pump, the remainder being drawn off by a mercury pump. The stem is then fused off and the lamp removed from the pump.

The lamps are then submitted to a photometric test, this being so arranged that all lamps are incandesced to a certain efficiency or number of candles per watt. A wattmeter with two scales is used, one reading in watts and the other in these watts and divided by a certain efficiency, that is, $3\frac{1}{2}$-watts per candle-power. The current through the lamp and its distance from the joly prism are both regulated so that the same candle power is given on the photometer bar as on the second wattmeter scale. The required pressure to give this balance is then read off on the wattmeter. The lamp is rotated while being tested. The lamps are then passed on to the packing-department, where the brass sockets, either bayonet or screw, are cemented on. A further series of tests have to be gone through before the lamp is finally passed for packing. These tests comprise examination for defect either in the fila-

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PART OF THE FACTORY AND STAFF AT "ROBERTSON" LAMP WORKS.

ment, the leading-inwires, or in the cap itself.

The "Wytelite" Lamp.

It was everywhere evident that the management intended to keep well to the front by embracing every known improvement, and by introducing new designs whenever possible. In this latter respect we were much struck with what is certainly a novelty in electric lamps, which had appropriately been dubbed the "Wytelite," and has been developed to supply a long-felt want in incandescent lighting. The lamp has many good features, but the chief of these are :

It fits an ordinary holder.
It gives a white light (25 c.p.) without shadow.
It does not blacken.
It needs no special attention.

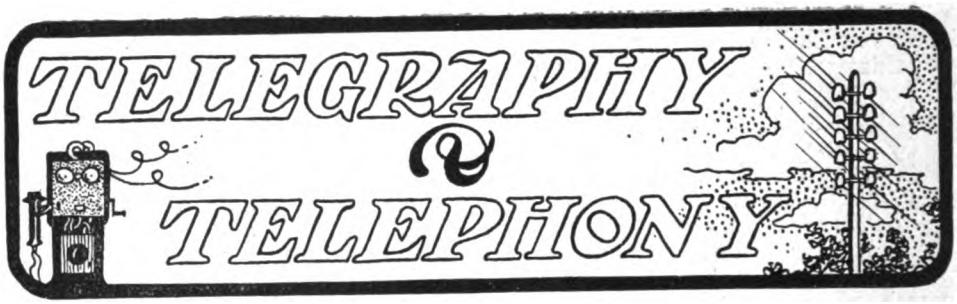
A special open-shade fits over the bulb, which is spherical, and as the lamp glass has been frosted almost to the cap, an even diffusion of light is obtained. The makers' claims for the quality and purity of the light are in no way exaggerated, as specimens we were able to inspect fully justified their statements. The idea is distinctly novel, and the best thing we have so far seen in improved incandescent lighting.

Conclusion.

From the above brief description our readers will clearly realise the difference between the making of a glow-lamp and the manufacture of a dynamo, that is, as far as the element of uncertainty is concerned. They will also understand how advantage can be taken by unscrupulous manufacturers to palm off on their consumers lamps which are either not submitted to a regular test or are the "throw-outs" of the testing-department. Throughout our tour of the Brook Green Lamp Works we were much impressed by the extreme care with which all the various operations were conducted. This was, however, especially noticeable in the testing-department, where each lamp was subjected to the keenest scrutiny and "turned down" without compromise if it failed to come up to standard. Consumers of electrical energy would do well to bear this fact in mind when ordering their lamps—that a good lamp is known by its name, and unless branded with this hall-mark of authority should be carefully avoided. We do not say this because we are prejudiced in favour of British-made lamps, but in the light of our experience of lamps from foreign sources, we think it expedient to impress the importance of being guided by a name rather than anything else.

We cannot but refer, in conclusion, to the exceptional facilities afforded the employees for social enjoyment out of working hours. These facilities have been thoughtfully provided, by the management, on the works themselves, where a large room has been set aside for entertainments, dances, lectures, &c. There is also an active athletic element which runs football and cricket clubs with considerable zeal and no small degree of success. We were treated to a splendid exhibition of skill on the part of the works fire brigade, which is well organised.

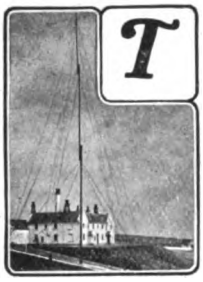
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For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

The Progress of Wireless Telegraphy in the United States.

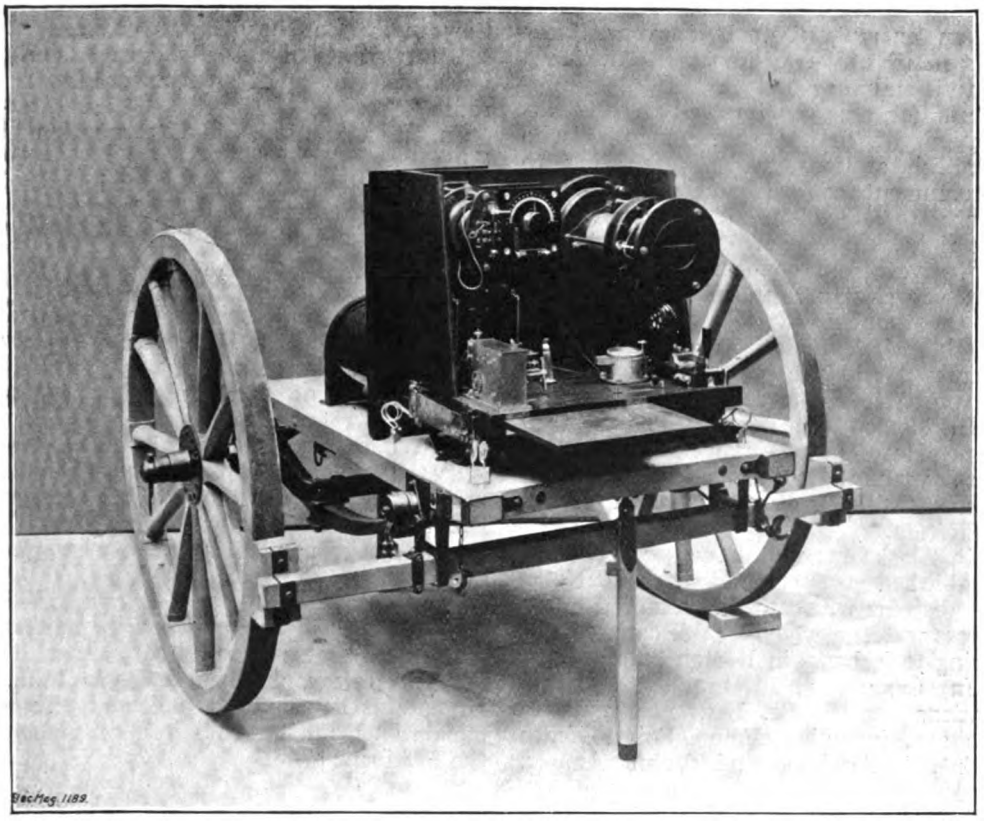
By E. O. WALKER, C.I.E., M.I.E.E.



THE naval authorities of the United States appear to have satisfied themselves that wireless systems are now thoroughly dependable for moderate distances, and the military experiments have enabled a distance of ninety-seven miles to be compassed at the creditable speed of thirty words a minute. This was achieved between Fort Wright, Fisher's Island, and Fort Schuyler, N.Y. Wireless telegraphy has also been established between Buffalo and Cleveland on the shore of Lake Erie, a distance of 170 miles. Encouraged by the success met with by the De Forest system in the Gulf of Pechili and elsewhere, the United States Government has entered into an agreement with the De Forest Company for the acquisition by the navy of five of the longest wireless telegraph circuits in the world up to this date, two of them, says the *Telegraph Age*, being more than 1,000 miles in length. The contract provides a supply of wireless instruments guaranteed to maintain trustworthy service in the circuits Key West to Panama, Porto Rico to Key West, South Cuba to Panama, Pensacola to Key West, and South Cuba to Porto Rico. A very large area is embraced within this area, our own possession, Jamaica, coming within it. There is, however, evidently from present experience no certainty that over these long distances communication can at all times of the day and in all seasons be maintained unimpaired. The service proposed is exceptional, as the signals will in some cases have to cross intervening islands such as Cuba and Hayti, and in the latter, and probably in others, run a risk of interference set up by apparatus not belonging to the United States Government. The contracting company assumes full responsibility for the working of the system in each case. A committee of naval and military officers, together with the chief of the Weather Bureau form a board to consider the question o wireless service. In the present instance the government has agreed to operate in harmony with such stations and vessels as now use the De Forest system as far as Panama. The government instruments will be tuned with those of the company. The navy will have the company's key, so that the two may work interchangeably, at the same time avoiding the risk of interference or violation of secrecy by vessels or stations equipped with other apparatus. There are very important stipulations. It is understood that the De Forest Company has secured a concession to establish their system between Bocas de Toro and Colon, and the latter place and Panama, with licence to connect with stations in other countries of Central and South America.

If any class of messages and description of news is likely to benefit by the wireless system it is the Meteorological despatch,

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GERMAN MILITARY WIRELESS TELEGRAPH STATION.

for many points admit of installations on this system which are incapable of being joined to land by cable. But the Weather Bureau, while keeping the matter in view, and while probably contemplating early arrangements, is not in the United States apparently ready to make a practical application of the invention to the public service. It has acquired the right to use a number of devices, among them several of Professor Fessenden's, but the proposal to instal thirty or forty land stations to communicate with ships at sea has not yet taken practical shape. While there is at present a special commission considering certain broad questions of policy affecting the government in its relation to wireless systems, it is unlikely that the Weather Bureau will proceed with the new organisation in question. Should the new departure take place it is possible that time signals may be passed to ships at sea by the same agency. The Bureau of Equipment of the Navy has, however, established twenty-two wireless telegraph stations along the coast, and have in contemplation a good many more in the United States and adjacent islands. At present the following places have been equipped for the necessities of the navy and mercantile marine: Cape Elizabeth, Portsmouth, Cape Ann, Boston, Cape Cod, Newport, Montauk Point, New York, Navesink, Cape Henry, Norfolk, Annapolis, Washington, Key West, Dry Tortugas, Pensacola, San Juan, Culebra, Yerba Buena Island, Mare Island, Cubras Island, and Cavité. During the coming year nearly three hundred thousand dollars will be spent upon wireless telegraphy work in the United States navy.

The question of the location of the stations is an important one, for although the coast line is most convenient, the stations will be exposed if within range

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to an enemy's fire. It is very likely that some stations will be a short distance inland, and that balloon and kite equipments for emergencies will receive attention. Whether the companies who establish stations, while submitting to Government control, and giving precedence to official messages, shall have the right, in all cases, to use the stations for private and commercial business, is not yet clearly arranged; should they be thus publicly available, the usefulness of the wireless stations will be lar ely increased and the cost of signalling will be probably reduced.

In Mexico the wireless telegraph at Cape Haro has continued during the past year to communicate with fair success with Santa Rosalia in Lower California.

In Alaska stations have recently been established between St. Michael and Nome the distance of about one hundred miles, across water in which a cable cannot exist owing to icebergs in Norton Sound.

In Canada there are six Marconi stations on the St. Lawrence route to the sea, including Fame Point, Heath Point, Belle Isle, and Point Amour. Communication has been carried on between points one hundred and twenty miles apart by an Allen liner taking this route.

In Nova Scotia there is a station at Cape Breton.

In addition to the Marconi system in use at the stations belonging to that company, and others, the Slaby-Arco system is being used, and the Lodge-Muirhead is finding favour and will probably be in considerable demand. For the moment the De Forest Company appear to be attempting a remarkably wide sphere of communication which has been referred to above. Captain L. S. Wildman of the United States army is stated to have adopted quite an independent system for the two stations of Nome and St. Michael on Norton's Sound, but particulars are not yet available.

[NOTE.—Since the above was written the United States Government Report on Wireless Telegraphy has come to hand. It contains lengthy and judicious recommendations which have been approved by the President]

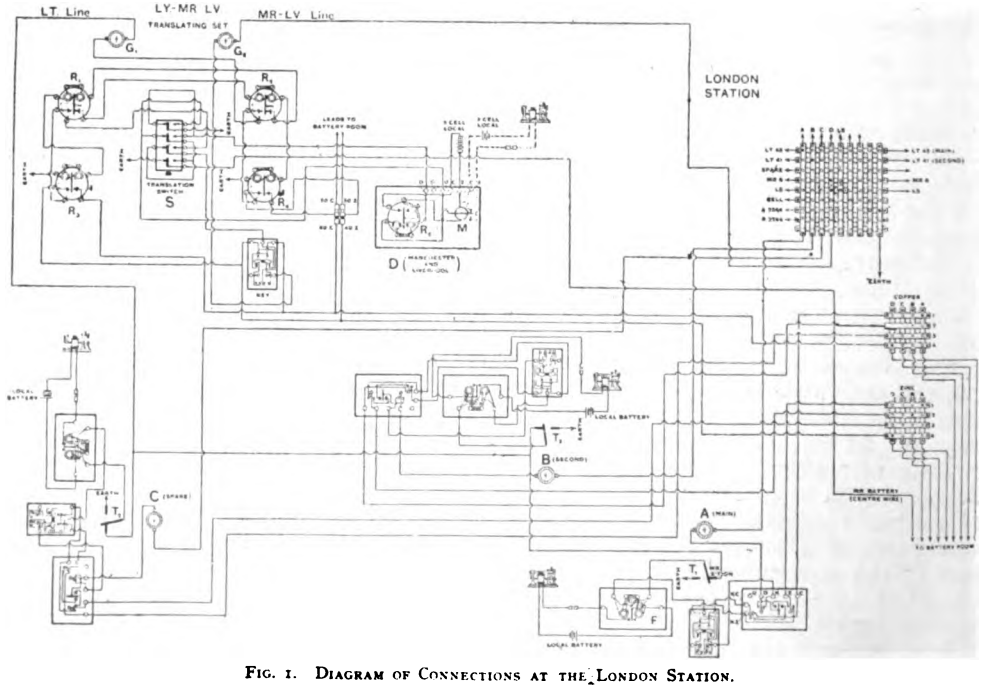


FIG. 1. DIAGRAM OF CONNECTIONS AT THE LONDON STATION.
(See article on opposite page.) [By permission of *The Electrician*.

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*England and Teheran Telegraph.**

By T. W. STRATFORD ANDREWS.

London Station.

THE London station (Fig. 1) has three principal circuits, A (main), B (second) and D (Liverpool and Manchester), and a spare set C, on to which any of the others can be switched at will. The Liverpool-Manchester line is worked as a through circuit, Manchester being the intermediate station. London's current is received at both stations. In setting up translation for that portion of the traffic destined for, or coming from, Liverpool and Manchester, several novel conditions presented themselves. It became necessary to be able to switch Teheran through to Liverpool or Manchester and to return to normal working on both sides at any moment, and at once, and to make the arrangement available for whichever of the three sets A, B, or D might require it. Further, it became necessary to be able to stop Manchester or Liverpool in the event of either of those stations being in the act of sending to London when translation was signalled for. This is accomplished by a device at Manchester and Liverpool by which, on the momentary turning of the key-switch in London, a bell is rung at the sending station. Switches T_1, T_2, and T_3 are provided, one at each of the three sets A, B, and C, and their function is to divert the line current after it has passed through the receiver coils F and transfer it to the translation set. This switch carries two additional terminals for the ends of a local circuit in which is included a small gong placed close to the translation set. The act of turning the switch handle from left to right, in addition to transferring the line current to the translation set, momentarily closes the local gong circuit, and signals the switching to the clerk at D.

* Excerpt from *The Electrician*.

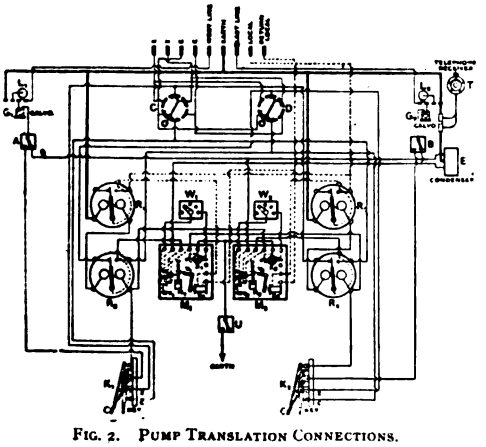


FIG. 2. PUMP TRANSLATION CONNECTIONS.
[By permission of *The Electrician*.

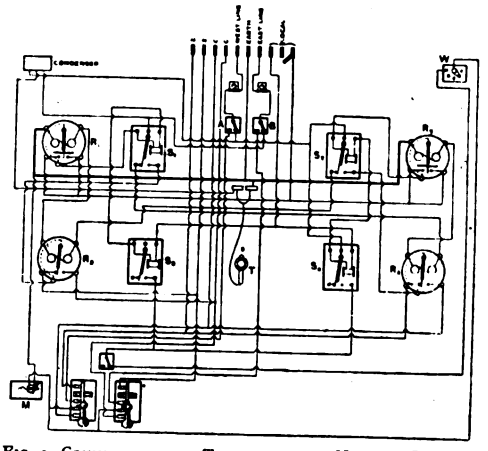


FIG. 3. CONNECTIONS FOR TRANSLATION BY NEUTRAL RELAYS.
[By permission of *The Electrician*.

"Evans" Translation London-Manchester-Liverpool (D).

Considerations of space and staff made it imperative that the translation and ordinary working should be carried on in one and the same place by one and the same clerk. The system of translation in use, which was devised by one of the company's staff, is marked by great simplicity. The whole operation, in both directions, is effected by four relays, and the essential parts of the system could be fixed on a board 18 in. square.

Let us suppose Teheran is sending a batch to London on the main (A) set. Suddenly the sounder raps out "M.R., M.R." (Manchester). The key clerk turns switch T_1, the gong at the translation set sounds, the clerk there turns the switch S, and Teheran's signals pass across and through galvanometer G_1 over the tongue and right-hand stop of R_2 into and through the coils of R_1 and R_3 to earth. The tongue of R_3 playing between its two stops, to which the poles of the line battery are brought, sends out the fresh current by way of the left-hand stop and tongue of R_1, through the barrel switch, the key and the galvanometer G_2 into the Manchester line. When Teheran has finished with Manchester he may have something for Liverpool and proceed with it, both these stations being in the one circuit. When he is finished with both, he signals LY (London) and the switches are turned back. Teheran continues sending to London and at the other table London resumes working with Manchester or Liverpool. The process of translation is the same when

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Manchester or Liverpool is sending to Teheran save that the incoming current after passing G_2, goes through key and barrel switch before reaching the tongue of R_1. No key is needed on the other side, as that on the main set is always in circuit.

The "Pump" Translation.

M_1 and M_2 (Fig. 2) are the "pump" switches. The coil S_2 is traversed by current in a local circuit closed by the contact of the tongue of R_2 with the right-hand stop. At the entry of the initial local current the armature of the right-hand lever V_2 is attracted, the upper arm falls, carrying the left-hand lever N_2 into the horizontal position, where it makes contact with the lower stop and with the spring contact Y_2, and at the same time forces a vertical rod or plunger carrying a disc at its lower extremity into a cylinder, H_2, partly filled with oil. This disc has a valve, and the oil displaced by the downward pressure of the disc rises through the valve to the upper surface. The upper extremity of the vertical rod is attached to the body of the instrument by an adjustable spiral spring. When the local current is shut off the armature of V_2 is released and the two levers, together with the plunger, would, by the tension of the spiral spring, regain the normal position at once were it not that the presence of the oil on the upper surface of the disc only allows the latter to rise slowly. Before this rise is sufficient to break the contacts of the left-hand lever N_2 the local circuit is again closed.

E is a condenser, or rather two condensers, each of 1 mfd. capacity. The inside plate of each condenser is joined through a telephone, T, to earth. They are charged, one by incoming, one by the outgoing current. When these two currents coincide in character and duration the results are harmonious and rhythmical vibrations of the telephone disc. This gives an audible and reliable indication of the working. Slow sending can be read by ear and a sounder dispensed with.

K_1 and K_2 are double current keys of the nutcracker type, and are only used occasionally for purposes of control, being brought into circuit by turning the switch A or B.

The "Pump" Translation in Action.

Line currents from the east pass through the lightning guard L_2 and galvanometer G_2, over switch B by the right-hand terminal, and there diverge to charge the condenser E and flow by way of the left-hand lever N_1 (of the pump M_1) through the top stop into and through the coils of R_4 and R_2 to earth. Being moved by positive currents to the right-hand stop, the tongue of R_2 closes a local circuit in which the coils S_2 (of M_2) are included. Until the eastern station stops sending the levers of this pump M_2 are brought to and kept in the translation position as already explained. The stops of R_4 are connected respectively with the Z and C poles of the line battery. Working under the influence of the incoming current the tongue sends on the fresh current to the lower stop at the left-hand lever N_2 (of M_2). At this point the current has two paths open, one by way of the spring contact Y_2 through a high resistance W_2 into the coils of the registering Morse X_2 and to earth, and by the other path through the lever N_2 itself, into the west line by A, G_1, and L_1 having charged the second condenser.

Translation with Neutral Relays.

This system of translation is well known (Fig. 3). The relays are all of the "Standard" type, and differ from the others only in that the tongues are held midway between the stops by the tension of springs acting from each side. Electromagnets are provided with shunts of a resistance equal to that of the coils with the object of increasing the effects of self-induction. The coils in a local circuit are closed by the movement of the tongues of the neutral relay in either direction.

AN APOLOGY.

We regret to find that the map on page 191 of our February issue (Telegraph Section) was inserted under a misapprehension, without the permission of "The Electrician" to whom the copyright belongs. We take this opportunity of tendering an apology to the proprietors of that journal for this inadvertent omission on our part.

Telegraphy Correspondence Class.—II.

Conducted by CICERONE.

OWING to the limited time between the issue of the February number and the preparation for the production of the succeeding one, the solutions to the first set of questions will not be dealt with until the April issue, and those appearing below will be treated in May. This arrangement will give students an extended period for answering the questions, and will allow them ample time to make any necessary references to works on the subject under review.

Solutions to the second set of problems may therefore be accepted up to April 20, and bearing upon them the following hints may be useful in the meantime.

The ideal primary cell should possess:

(1) A high and constant electromotive force.

(2) A low and unvarying resistance.

(3) Freedom from polarisation and local action.

(4) Cheap and durable constituents.

(5) Immunity from waste when idle.

(6) Freedom from the emission of noxious and corrosive fumes.

(7) Easy access for examination on renewal of contents.

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No cell yet devised possesses all these qualities, nor is there ever likely to be one, but a good deal can be accomplished, by attention to details and in the arranging and grouping of cells, to attain the majority of these desiderata.

The electromotive force of a cell depends upon the nature of its plates, and of its other constituents, but not upon their size or volume. Between any two dissimilar metallic plates there exists a certain definite potential difference, and there also exists a difference of potential between the plates and the decomposable liquids or electrolytes in which they are immersed. This potential difference is a constant measurable quantity determined in terms of its unit—*the volt*. Any variation in this quantity, or voltage, is generally due to a variation in the density of the electrolyte, or to some change in the physical condition of the plates, such as polarisation, local action, &c.

Before an electric current can be maintained in a circuit, the potential, or electromotive force (e.m.f.), must overcome the resistance encountered in the cell itself, as well as that in the external path provided between the terminals of the cell. This quantity is also constant and definite, and only alters with changes in the physical condition of the materials composing the internal and external paths. It is measured in terms of its unit—*the ohm*—and depends internally upon the size, as well as the nature of the plates, and also upon the volume, nature, and density of the other constituents composing the cell.

A cell having large plates, placed close together, furnishes a large conducting area, and the current, not having far to travel between the plates, is said to encounter a small resistance, or it may be otherwise expressed by saying that such a cell has a high conductivity, resistance being the converse of conductivity. On the other hand, a cell having very small plates, situated far apart in the exciting liquid, will offer a high resistance to the current, and when porous partitions are interposed either to prevent two liquids from co-mingling, or for the purpose of supporting a depolarising material surrounding one of the plates, they introduce an additional resistance in the path of the current and so enfeeble or impoverish its strength.

The current (C) depends directly for its strength on the e.m.f. applied, and is inversely proportional to the resistance in its circuit.

With a steady e.m.f. (E) and a constant resistance (R) the current may be taken as the ratio of E to R, but it can be measured absolutely, in a variety of ways in terms of its unit—*the ampere*. For telegraphic purposes this unit is too large, and a sub-unit, termed the *milliampere*, or one-thousandth of an ampere, is employed.

From what has been stated it will be obvious that, in order to obtain what is called a strong current, plates should be selected from two metals having the largest possible difference of potential existing between them, and they should be of sufficient size and in close enough proximity to offer a minimum of resistance. The same general rule applies to the choice of electrolytes.

Cells may be grouped or connected together in several ways, according to the e.m.f. and resistance desired. By joining a number of cells (n) in series, that is, the negative of one to the positive of the next, and so on throughout, the total e.m.f. will be equal to the sum of the separate e.m.f.s of all the cells so joined, and the total resistance will be the sum of all their separate resistances. Generally speaking, the e.m.f. and resistance of a number of similar cells are all about equal, so the total e.m.f. and the total resistance may be taken as the e.m.f. and the resistance of one cell multiplied by the number of cells joined in series.

Twenty cells of 2 volts and 3 ohms each would have a total E of 40 volts, and a total R of 60 ohms, the current being directly proportional to E and inversely proportional to R, or 0.6 ampere. If it is desired to reduce R a number of cells may be joined in parallel, or in multiple, as it is sometimes called. That is, all the positive plates of a given number should be joined together, and all the negative plates likewise. This will have the effect of creating that battery into one large cell, the e.m.f. of which will only have the value of one cell, but whose resistance will only be $\frac{1}{m}$th of that of one cell, m being the number joined in parallel.

If a certain number (n) of a group be joined in series, and another number (m) in parallel, the resistance (R) of the combination will be $R = \frac{nr}{m}$, where r is the resistance of one cell.

To obtain the maximum current from any given number (T) of cells, for an external circuit of R_1 ohms, R should be made equal to R_1, or $\frac{nr}{m} = R_1$

But $T = nm$

$$m = \frac{T}{n}$$

and $$R_1 = \frac{nr}{\frac{T}{n}} = \frac{n^2 r}{1}$$

$$n^2 r = TR_1$$

$$n^2 = \frac{TR_1}{r} \therefore n = \sqrt{\frac{TR_1}{r}}.$$

E

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When a current passes through a voltaic cell, certain actions and reactions take place, depending of course upon the constituents of the cell, but may be broadly formulated as (1) the zinc, or other combustible material is consumed, (2) the electrolyte is decomposed, (3) its molecules undergo certain transformations, and (4) a certain amount of heat is generated, heat being a universal accompaniment of the electric current.

The amount of heat (H) evolved during any period of time (t) is directly proportional to the e.m.f. (E) applied, and to the strength of current (C) or in symbols

$$\begin{aligned} H &= EC\mathit{t} \\ \text{But } E &= CR \\ \therefore H &= CRCT \\ &= C^2RT \end{aligned}$$

This law is important in the calculation of safety fuses, and should be thoroughly grasped.

The electric unit of heat is called after Joule, who investigated the question of development of heat by an electric current, and is only 0.24 of a calory, or ordinary heat unit.

The effect of raising the temperature of a cell is to increase the current or lower the resistance, this being opposite to the result of increased temperature in a metal conductor. By increasing the current, the consumption of zinc and the deposition of any metallic substance contained in the electrolyte are also increased, the increase depending upon the electro-chemical equivalent of the materials.

A voltaic cell resembles a furnace in so far as it consumes a substance in evolving an electric current in the same way as the furnace consumes a substance in producing heat. Further, the quantity of heat produced by a substance is a measure of the amount of current that the same substance will furnish when consumed in a cell. By arranging all substances in the order of their heat values, a list of the most suitable materials for a voltaic cell may be had at convenience. In all good text-books such lists are given.

Before an electric current can be obtained for useful purposes outside the cell, it must first overcome the resistance (r) of the cell itself, and by so doing, a certain proportion of the voltage (v) is lost. This is usually referred to as the lost volts, in contradistinction to the useful volts (V) obtainable on the terminals of the cell or battery. The potential or voltage in any part of a circuit can be readily calculated from the current and the resistance in that part. For instance, the lost volts, $v = Cr$, and the useful volts, $V = CR$, where R = the resistance of the external part considered.

The total available or useful volts then $= V = E - Cr$ where E = the total e.m.f. of the battery or cell.

In calculating the number of cells (n) required to produce a current (C) in an external circuit R

$$n = \frac{CR}{e - Cr}$$

where e = the e.m.f. of one cell and $e - Cr$ = the available voltage per cell.

EXERCISE II.—MARCH 1905.

1. (*a*) DEFINE, as briefly as possible, Ohm's Law.

(*b*) How many cells of 2.1 volts and 3 ohms each would be required to provide a current of 15 milliamperes at the distant end of a line of 2,500 ohms, with a leak of 1,000 ohms at its centre ?

2. (*a*) Calculate the number of calories developed in a wire of 10 ohms after having an e.m.f. of five volts applied to it for ten minutes.

(*b*) What change in the amount of heat would result from a reduction of the current by a half ?

3. (*a*) How would you group thirty Leclanché cells of 1.6 volts and 1.5 ohms each, so that the current in an external circuit of 50 ohms would approximate that from ten Bichromates of 2.1 volts and 3 ohms each ?

(*b*) What resistance would have to be added in order that the current would be the same in each case ?

4. (*a*) Calculate the quantity of zinc consumed in a battery of twenty cells, with a steady current of 0.115 ampere flowing for half an hour, if 0.045 oz. of zinc is consumed per ampere-hour per cell.

(*b*) What effect would an increase of temperature have upon the amount of zinc consumed ?

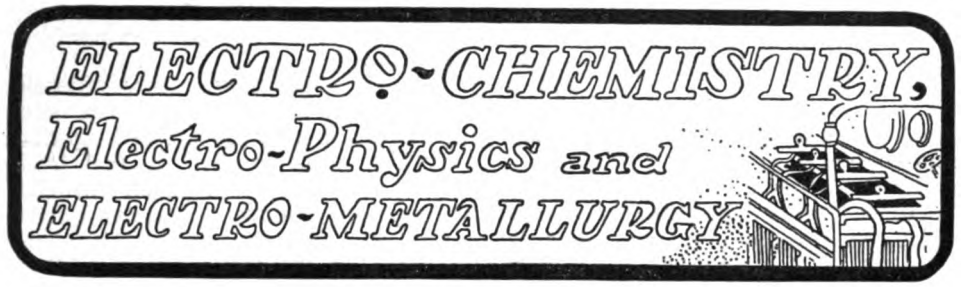
5. (*a*) Fifty volts are applied to the terminals of three parallel circuits of 10, 15, and 20 ohms respectively. What is the strength of current in each ?

(*b*) What voltage is lost in the battery when all three circuits are working, if the battery resistance is 10 ohms ?

6. (*a*) Compare the current in a line of 30 ohms from twelve cells in series, with that from four cells in series, and two in parallel (total eight cells). The cells have each 2 volts and 10 ohms.

(*b*) What must be the greatest resistance that a battery may have, so that in no case the current will vary more than 25 per cent., in six parallel circuits of 500 ohms each ?

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Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

Electro-Metallurgy in 1904.

By JOHN B. C. KERSHAW, F.I.C.

(Concluded from p. 197.)

THE writer in an article published in the February issue of this Magazine dealt with the present position of the electro-metallurgical industries in the United Kingdom, France, and Germany, and pointed out the lines upon which these are now developing in the three countries named.

In this article it is proposed to deal in a similar manner with the industries in the remaining countries of Europe.

Austria.

The manufacture of *aluminium* in Austria is carried on by the Neuhausen Aluminium Co., at Lend Gastein and at Lend Raweis — two new water-power centres in the Austrian Alps. This company now controls over 24,000 h.p. in its four factories, and is manufacturing other electric-furnace products in addition to aluminium.

Few details are available relating to the two Austrian works. The Lend-Raweis power installation is equivalent to 6,000 h.p., and is obtained from a fall 130 metres in height. The transmission line connecting this new power-plant with the works at Lend Gastein is eight kilometres in length, and is presumably of aluminium. The capacity of the Lend Gastein works is now 15,000 h.p., but the writer has been informed recently by Dr. Engelhardt of Vienna, that only 4,000 h.p. is yet utilised in the manufacture of aluminium and calcium carbide at this place. The original power development at Lend Gastein was obtained by use of a fall of 63 metres on the River Achen, and the plant at this place was valued at £150,000 in 1902—as compared with Neuhausen, £200,000, and Rheinfelden, £237,000. Recent developments at Rheinfelden and at Lend Gastein have, however, added considerably to these totals for capital expenditure.

As regards *calcium carbide* manufacture, a large number of works were planned for erection in Austria during the period of boom in this industry (1898–1900), and a considerable proportion of these were actually built and put into operation. The collapse in this industry which marked the years 1900–1902, of course affected prejudicially the position and prospects of these works, and, in some cases, the manufacture of carbide has been suspended and the power devoted to other purposes. In 1900, eight carbide works were in operation in Austria, and three others were in course of erection. At the present moment, according to a reliable authority, calcium carbide is produced at only three works in Austria, namely, at Jaice, at Lend Gastein, and at Meran. The large works which were projected at Paternion were erected, but have never been operated in a regular manner, and at present are stopped. No details can be obtained as to the power utilised or carbide produced in the three works named above.

The only other electro-metallurgical product known to the writer as being manufactured in Austria at the present time, is *ferro-silicon*. This is produced on a large scale at Jaice, by the Bosnian Electrical Co., but no details of the power used or of the annual production

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of this alloy can be obtained. The Jaice works were erected by Schuckert et Cie. in the years 1896–1898, and a power development of 8,000 h.p. was planned and partly carried out. A fully illustrated description of this works was given by the writer in *Cassier's Magazine* in October 1901. Originally it was intended to manufacture only alkalies and bleach, and carbide at Jaice, and 2,000 h.p. were devoted to the latter product. The fall in the price of carbide, however, in 1900 caused a change in these plans and reduction in the output of carbide, and, as already stated, *ferro-silicon* is now being produced in the furnaces and plant erected for carbide production in 1899 at Jaice.

Italy.

The electro-metallurgical industries are represented in Italy by the works for production of aluminium, calcium-carbide, and iron and steel.

Aluminium. The manufacture of aluminium has not yet commenced in Italy, but a company has been formed during 1904 with headquarters in Rome, for promoting the manufacture of the light metal in that country. It is intended to utilise a water-power in the Valley of Pescara in this industry, and to obtain the purified alumina required as raw material from native bauxite which has been found near Abruzzio.

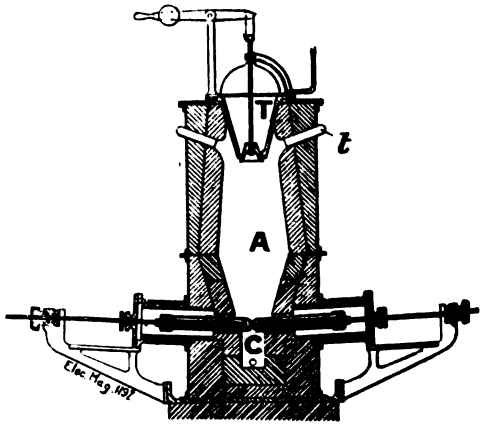
The Italian Electrochemical Co. and one or two German banks are financing this undertaking.

As regards *calcium carbide*, Italy has taken up this manufacture with eagerness, and in 1900 seven Italian works were in operation and one was in course of erection. No very reliable information can be obtained as to the present position and prospects of these eight factories; but it may be safely assumed that not more than four of them are now producing carbide. According to Dr. Bolis, 250 tons of carbide were produced in Italy in 1897, 1,400 tons in 1900, and 4,800 tons in 1902. No figures are available for the output in 1903 and 1904, but the consumption of carbide in Italy is rapidly increasing, owing to the very large number of central acetylene generating plants which have been erected in the last two years, and in 1902 it was estimated that 12,500 tons of carbide were required for the home consumption.

The carbide industry in Italy is therefore slowly recovering its position, and though prices are still very low, there is no doubt that the best-managed of the Italian carbide companies, if provided with cheap water-power, can now operate at a profit.

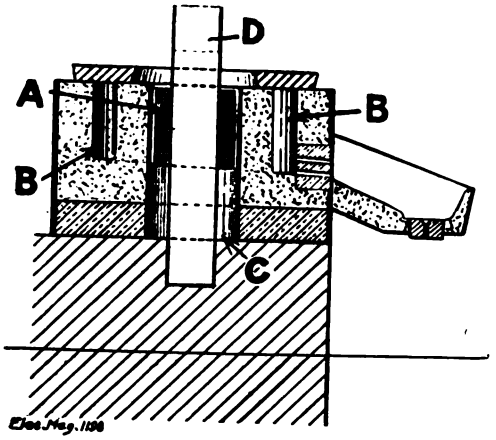
The reports of the various companies published in the Italian paper *Elettricita* during 1904 show, however, that the collapse of prices in 1900 and over-production in Europe during the period 1900–1903 has left some of the Italian carbide companies in a very serious position as regards finances—and one of the largest is reported to have lost one-quarter of its capital. In spite of this unfavourable financial position of one of the older companies, a very large carbide works has been erected at Sebenico during 1904, and 5,000 tons of carbide is to be produced per annum at this place, with power transmitted seven and a half miles from a large power station at Kerka in Dalmatia. The company financing this undertaking is also projecting a still larger carbide works in connection with another water-power centre in Northern Italy.

The manufacture of *iron and steel* in Italy by the electric furnace is still in its experimental stages. Trials upon an industrial scale have been proceeding since 1899, with the Stassano process and furnace, but these cannot be said to have yet led to any striking industrial development. The Stassano process aims at producing high-class steel in one operation from the ore, the crushed and roasted ore being made into *briquettes* with the



THE STASSANO FURNACE.

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SECTION THROUGH KJELLIN FURNACE.

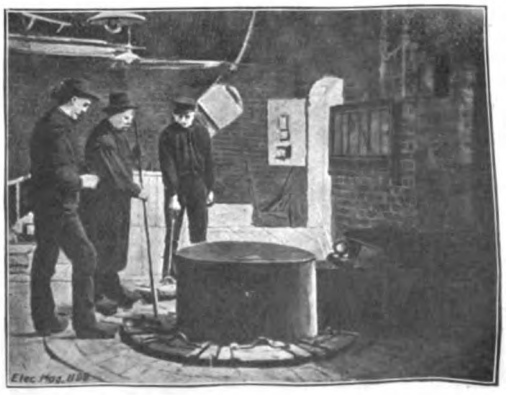
necessary amount of coke and lime, and heated to fusion in a revolving electric arc furnace.

The original experiments with this process were carried out at Rome, and were then continued at Darfo, in Northern Italy, and here the furnace and process were seen in operation by Goldschmidt in 1901, and a report was prepared on them for the German Patent Office. The company financing the industrial trials, however, came to the end of its resources before any definite success had been obtained, and the experiments are now being continued at the Royal Arsenal at Turin at the expense of the Italian Government. It is said that steel of much better quality than that produced in the earlier trials can now be obtained by the Stassano process, and that .186 e.h.p. year only, is required to produce one ton of steel from scrap iron in this type of furnace. In the writer's opinion, however, it is unlikely that steel can be produced in one operation from the ore in the Stassano furnace *at a profit*—at the present time—since the costs of preparing the *briquettes* will handicap the process in its competition with the older methods. For refining scrap iron and steel and production of special alloys the Stassano furnace may, however, have a useful future before it in Italy.

Switzerland.

Aluminium is produced in Switzerland by the Neuhausen Aluminium Co., this being the first works in Europe where the light metal was produced by the electro-metallurgical process. The Neuhausen works were erected in 1889, and commenced to produce alloys of aluminium with copper by the Heroult process in the same year. Originally pure alumina was employed as electrolyte, but a very high temperature was necessary in order to fuse this, and investigations by Kiliani and Heroult led to a modification of the first patented process, and to the use of a fused mixture of sodium and aluminium fluorides as solvent for the aluminium oxide. The temperature of the bath was in this way greatly reduced, and the necessity for producing alloys in place of pure aluminium was avoided. Aluminium has been produced by this method at Neuhausen since 1890, and 4,000 h.p. is reported to be utilised in the manufacture at this place. No details of the plant or of the process have been published, and as the Neuhausen Co. now owns four distinct works and controls over 24,000 h.p., no figures can be given for the separate production of the Neuhausen plant. Calcium carbide is produced at Neuhausen in addition to aluminium.

Calcium carbide is produced at a large number of places in Switzerland, fourteen works having been planned during the early days of this industry and eleven of these having been erected and operated during 1899–1900. Several of these works have been shut down in recent years, owing to the heavy fall in the selling price of carbide, and others have taken up the manufacture of ferro-silicon and



KJELLIN FURNACE AT GYSINGE, SWEDEN.

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similar alloys. A revival of the carbide industry is now occurring, and one or two of these works have been provided with new and improved plant and are again producing carbide.

According to a recent report, the works at Thusis is one of these, and here the manufacture was recommenced at the end of July 1904. A new type of electric furnace for carbide production has been erected in this works, and four tons of carbide of very high quality are produced per twenty-four hours. The only figures available relating to the Swiss carbide productions show that 24,000 h.p. is available for the manufacture, and that the export trade in this product is increasing. In the year 1902 Switzerland exported 3,070 tons of carbide, in addition to meeting the home demand.

FERRO-ALLOYS. *Ferro-silicon* is produced in Switzerland at the works erected at Landeck and Mattrei, which are also reported by Elbs to be manufacturing *silicon-copper*. These two works were originally engaged in the carbide industry. *Special alloys of iron and steel* are also about to be produced on a large scale at Courtepin by the Girod furnace and process. The Girod furnace is of the crucible type, and an external resistance is employed for producing the heat required to melt the metal contained in the crucible. The largest furnaces of this type yet made absorb 200 h.p., and produce 2,000 kgs. of steel per day.

The Courtepin works are reported to have 4,000 kw. available, and ferro-alloys of silicon, molybdenum, tungsten, chromium, and vanadium are to be manufactured at this new centre of electro-metallurgical industry.

Special.

In our next issue we shall publish in this section an article expressly written for this journal by Dr. F. Mollwo Perkin, entitled "The Electrolytic Preparation and Production of Calcium, Strontium and Barium."

The National Physical Laboratory.

Extract from Report of the Director for Year ending December 31, 1904.

Physics Department.

I. ELECTRICITY.

Fundamental Units (*Mr. Smith*).

(*a*) *Standards of Resistance.*—An intercomparison has been made of the mercury standards of resistance constructed last year. The differences found were in agreement (within the limits of the errors of observation) with those previously observed. The methods of building up resistance coils, having values in ohms approximately equal to some power of ten, have been investigated. The evaluation of a 10-ohms coil, by placing ten-unit coils in series, or by Lord Rayleigh's most convenient "build up" of three 3-ohms coils capable of being placed in series or in parallel, is not sufficiently accurate for standards purposes. Build-up boxes have been designed consisting of coils having resistances in the ratio of the numbers 1.1.2.2.5.10, the arrangement of the coils being such that the lines of flow are of the same form when the separate coils are being evaluated as when they are placed in series. No contacts form part of the resistance measured, and careful checking proves the build up to be accurate to 0.0001 per cent.

(*b*) *Standard Cells.*—The investigation of certain anomalies of Clark and cadmium cells has been continued. Special four-limb cells were constructed, designed so as to contain three different samples of any one element of the cell. In this way the instability of the samples was determinable. Mercurous sulphate was the first substance to be investigated, the observations of previous years indicating its behaviour to be most unsatisfactory. The investigation proved the sulphate, as ordinarily prepared, to be quite unsuitable for standard cells, and a standard method of preparation was sought. Three methods proved to be successful. The first of these is a modification of one due to Divers and Shimidzu, the salt being prepared with fuming sulphuric acid and mercury. The second is a precipitation method, while the third is an electrolytic method, due to Prof. H. S. Carhart, Mr. G. A. Hulett, and Dr. F. Wolff. Very satisfactory results were obtained. Six cadmium cells, prepared with samples of mercurous sulphate so made, were taken to the United States by Dr. Glazebrook in September, the object being to compare their e.m.f.s with those of other cells constructed by Prof. Carhart. Unfortunately, the cells changed in transit; the reason for this is unknown, but will be investigated.

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There is little doubt, however, but that a depolariser can now be prepared, such that the e.m.f.s of cells prepared with samples manufactured at different times will not be different by more than a few hundredths of a millivolt. With purchased samples of mercurous sulphate, cells were prepared having e.m.f.s different by more than two millivolts.

An investigation has also been made to determine the difference, if any, of e.m.f. between the H form of cell and the tube or Board of Trade form. Since 1892 the H form has been assumed to have a smaller e.m.f. by 0.0004 volt. Cells combining the two forms were constructed, and observations made on both Clark and cadmium cells. The results showed conclusively that no difference so great as four ten-thousandths of a volt exists; the difference, if any, must be very small.

(*c*) *Ampere Balance of the British Association.*—The construction of the electrical portions of this has been the principal work of the year. The weighing mechanism was completed by Mr. L. Oertling in April, and was tested at Mr. Oertling's works, the results being entirely satisfactory. The four marble cylinders for use with the balance have been wound and successfully insulated. The turning and screw-cutting of these was performed by Mr. Taylerson, of the Engineering Department of the Laboratory. The two large fixed cylinders have diameters of 13 in., and are each 11 in. long. The small suspended cylinders are 8 in. in diameter, and approximately 6 in. long. On each fixed cylinder are two double helices of No. 24 bare copper wire. The pitch of each helix is $\frac{1}{18}$ in., so that the air space between consecutive turns is less than six-thousandths of an inch. Double helices are also wound on the small cylinders. The object of the double helix is to enable the insulation resistance between the strands to be measured. Initially, this insulation resistance was surprisingly low, and great difficulty was at first experienced in raising it to more than a few hundred ohms. Finally, however, an insulation resistance greater than 30,000 megohms was secured for each pair of coils. To obtain the mean diameter of the coils measurements were made in nine or ten approximately equidistant planes, and fourteen observations made in each plane. A complete survey of the surface of the coils was thus ensured. The measuring apparatus was specially designed, and enabled the diameter of any turn to be determined. Readings could be repeated to one micron. The observed diameters have been plotted so as to illustrate the ellipticity and conicality of the cylinders. The average ellipticity is such that the diameters of the ellipse vary by about ten micron, while the average difference between the maximum and minimum means of the readings in the various planes is about twelve micron. This latter is a rough measure of the conicality. The dimensions of the coils are probably known with greater accuracy than any coils hitherto constructed. Many accessories for the balance have also been constructed, and there still remains much delicate fitting to be done. The outlook for a speedy determination of the absolute unit of current is, however, very hopeful.

General Measurements (*Mr. Campbell and Mr. Melsom*).

Tests.—Of special interest may be mentioned the following:

A number of the leading British instrument makers who were exhibiting at the St. Louis Exhibition had a wide variety of their instruments verified by the Laboratory before sending them to St. Louis. Most of these instruments were intended for measurements of the highest order of accuracy, and the list included many kinds of resistance boxes, several types of potentiometer, insulation and conductivity testing sets, and standard resistances from 0.001 ohm to 1 megohm. Some small self-inductances of the order of 0.2 to 5 millihenries were measured by Wien's method. In this method a high frequency alternating current is used, and this was furnished by a microphone buzzer giving 700 complete periods per second. Ultimately the buzzer was modified and improved so that an almost pure sine curve alternating current, with a frequency as high as 2,000 periods per second, was obtained. An increase of frequency of this amount is of great advantage, as it so increases the sensitiveness of any method used. The small inductances were also compared with larger standard ones already tested (at lower frequencies) against the Standard Air Condensers by Anderson's method; the agreement was satisfactory. In order to find if any change, due to alternating currents at high voltages, could be detected in a copper conductor, measurements of electrical conductivity were made on samples of Ferranti concentric mains (*a*) which had been in use with high voltages for many years, and (*b*) which had stood idle for the same period. The results showed that no difference due to use could be detected.

Early in the year a set of preliminary experiments were made on a number of samples of gutta-percha, and from these were arranged the methods for the actual tests of a large series of samples done later in the year, chiefly by Mr. White and Mr. Rayner. The apparatus used is described below. The gutta-percha samples were in the form

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of sheets and the coverings on wires (in quarter-mile lengths). For each sample there were two thicknesses of material both for sheets and on the wires. The material was tested for dielectric resistivity at a number of different temperatures, the effects of ageing being found by repeating the tests at intervals extending over six months. Most of these tests were made both with 200 and 1,000 volts, and with one and two minutes' electrification. In addition to the usual direct deflection method, in many cases the loss of charge method was also used. With both the wires and the sheets several series of tests of specific inductive capacity were made, and the effect of varying the temperature was tested. It may be of interest to mention that resistances of the order of 1,000,000 megohms were dealt with by the direct deflection method.

Tests on Laboratory Instruments, &c.— The Standard B.A. Air Condensers were tested, and a higher degree of accuracy than in former determinations was obtained by using a chronograph in conjunction with the standard clock. Some tests of temperature co-efficient were made on several mica condensers.

For the gutta-percha tests a large water-tank was set up; the water in this could be maintained within 0°.1 C. by means of an electrical thermometer relay which controlled a number of electric heaters at the bottom of the tank. For the calibration of the galvanometers used in the high-resistance tests a subdivided resistance of 100,000 ohms was constructed, capable of bearing easily 1,000 volts. The voltage was measured by an electrostatic voltmeter across a suitable fraction of the resistance. Another resistance of 100,000 ohms was built to act as the standard in the galvanometer circuit. A set of five non-inductive resistance frames (each 50 ohms and to carry 2 amperes) was constructed. By means of these, comparisons were made, both with direct and alternating current, of one of the Standard Kelvin Electrostatic Voltmeters and one of the Kelvin Balances (to 100 amperes). The agreement was quite satisfactory, and this disproves (for ordinary frequencies) the allegation that when used with alternating currents the accuracy of the Balance is affected by eddy currents in the metal parts near the coils.

In Magnetic Testing a number of experiments were made on a modified form of the Isthmus Method with a view to reaching flux densities of 22,000 to 23,000. For hysteresis and other magnetic tests a special stand was made by which a primary winding of thirty turns could be applied to a ring in a few minutes. On testing this arrangement the results obtained were in satisfactory agreement with those obtained from the same ring evenly wound in the usual manner. For hysteresis tests a Searle Ballistic Wattmeter was set up, and by its help a measurement of hysteresis can be got by observing four throws of the moving coil—a considerably quicker method than the standard one of drawing the hysteresis loop and measuring its area. As this wattmeter must be very sensitive, considerable difficulties arose with it in the earlier part of the work. Three sources of error were traced and almost completely eliminated. These were:

(*a*) Insufficient inductance in the choking coil used to delay the rise and fall of the magnetising current.

(*b*) Electrostatic action of the series circuit on the moving coil and damper.

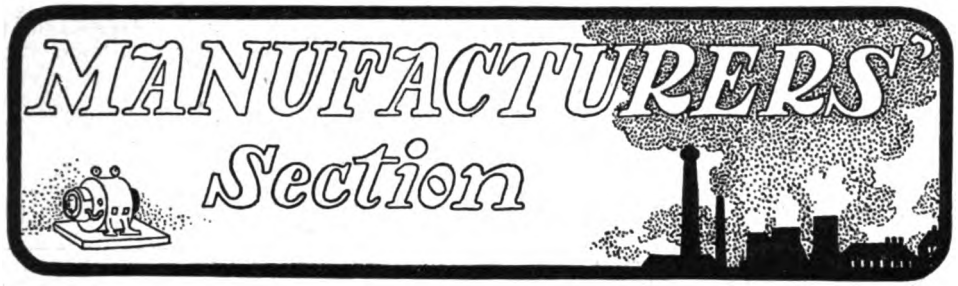
(*c*) Air convection currents caused by the heating of the series coils, which are run at a high current density.

To get over (*a*) a large subdivided choking coil (with closed iron circuit) was built. The electrostatic action (*b*), which was largely due to the necessity of working from a portion of the 100-volt experimental battery, was almost eliminated by applying suitable strips of tinfoil to the surroundings of the moving coil. The convection currents (*c*) were much reduced by placing the series coils further apart and screening the moving coil from them by thick shields of ebonite. For calibrating the wattmeter a simple magnet inductor (a coil slipping over a permanent magnet) was constructed. It is used as a working standard of magnetic flux, being checked from time to time against a standard mutual inductance. The wattmeter method has been used to test a number of rings, and so far the results have been in good agreement with those given with the same rings by the ordinary ballistic galvanometer method. Some comparison tests were also made on a Ewing Hysteresis Tester.

Electrotechnics (Mr. Paterson).

Equipment. — Progress has been made during 1904 in the equipment of an electrotechnical department to undertake the testing of electrical apparatus on a commercial scale, and it is hoped that early in 1905 the installation of the necessary apparatus will be complete. For direct-current work cells have been installed with a capacity of 1,000 amperes, and a plug-board and resistance has been fitted for regulating this current. There are three Kelvin balances with capacities up to 600 amperes connected to a board which enables any one to be put in circuit as desired.

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A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section at end of Magazine.

THE PRESTON WORKS OF DICK, KERR AND CO., LTD., AND THEIR ELECTRICAL MANUFACTURES.



THE history of Dick, Kerr and Co., Ltd., linked as it was in 1900 with the rise and development of the English Electric Manufacturing Co., is a continuous record of splendid achievement on behalf of those electrical rights and properties of the Britisher which at one time were in danger of usurpation. We know of no better answer to the oft-repeated gibe at British electrical men of being behind other great nations of the world than the extensive works of Dick, Kerr and Co. which we were recently privileged to visit at Preston, Lancs. The past few years has witnessed much dumping of electrical machinery and apparatus in this country by American and Continental firms, a proceeding which has tended to distort the views of many of our own engineers into belief in designs and standards quite out of keeping with our needs. In contradistinction to this policy has been that of the British firms proper, which have preserved their individuality in meeting the demands of the home and colonial market. Prominent among these is the company whose works and electrical products we propose to briefly pass in review, while emphasising the important position they occupy among concerns which we have now come to regard as essentially associated with British electrical methods.

THE WORKS.

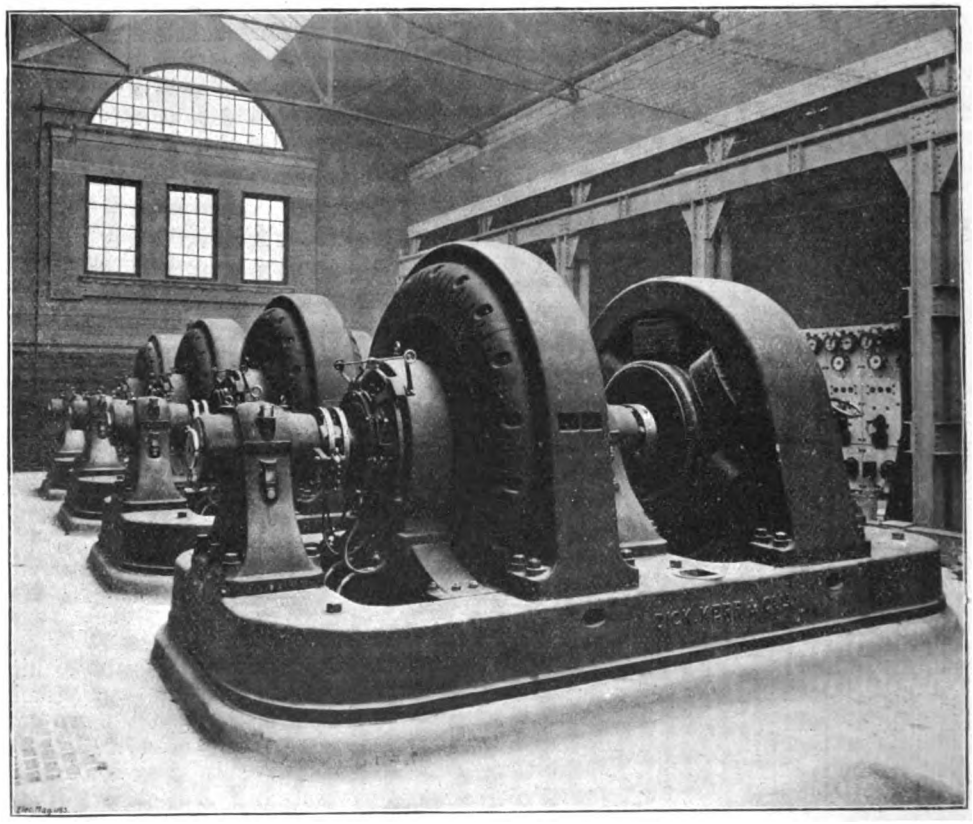
The site of the works is some twelve acres of land on the river Ribble, at Preston, a location admirably suited for serving both the home and foreign markets, being contiguous with two great railway systems and the port of Liverpool. Transport facilities are thus available to ensure prompt delivery either in this country or abroad. The buildings are all one-storey structures, except the offices, of steel and brick construction, the former serving only to support the cranes and roof, and they are abundantly lighted from the roof and sides. The lay-out of the works permits of extensions being conveniently carried out without entailing serious constructional modifications. The works are made up of a foundry building, containing the pattern-shop, iron and brass foundries, a large machine-shop comprising two long bays devoted to the assembly of generators and motors respectively, and a roomy power-house which furnishes

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electrical energy for operating the cranes and tools and for lighting the works.

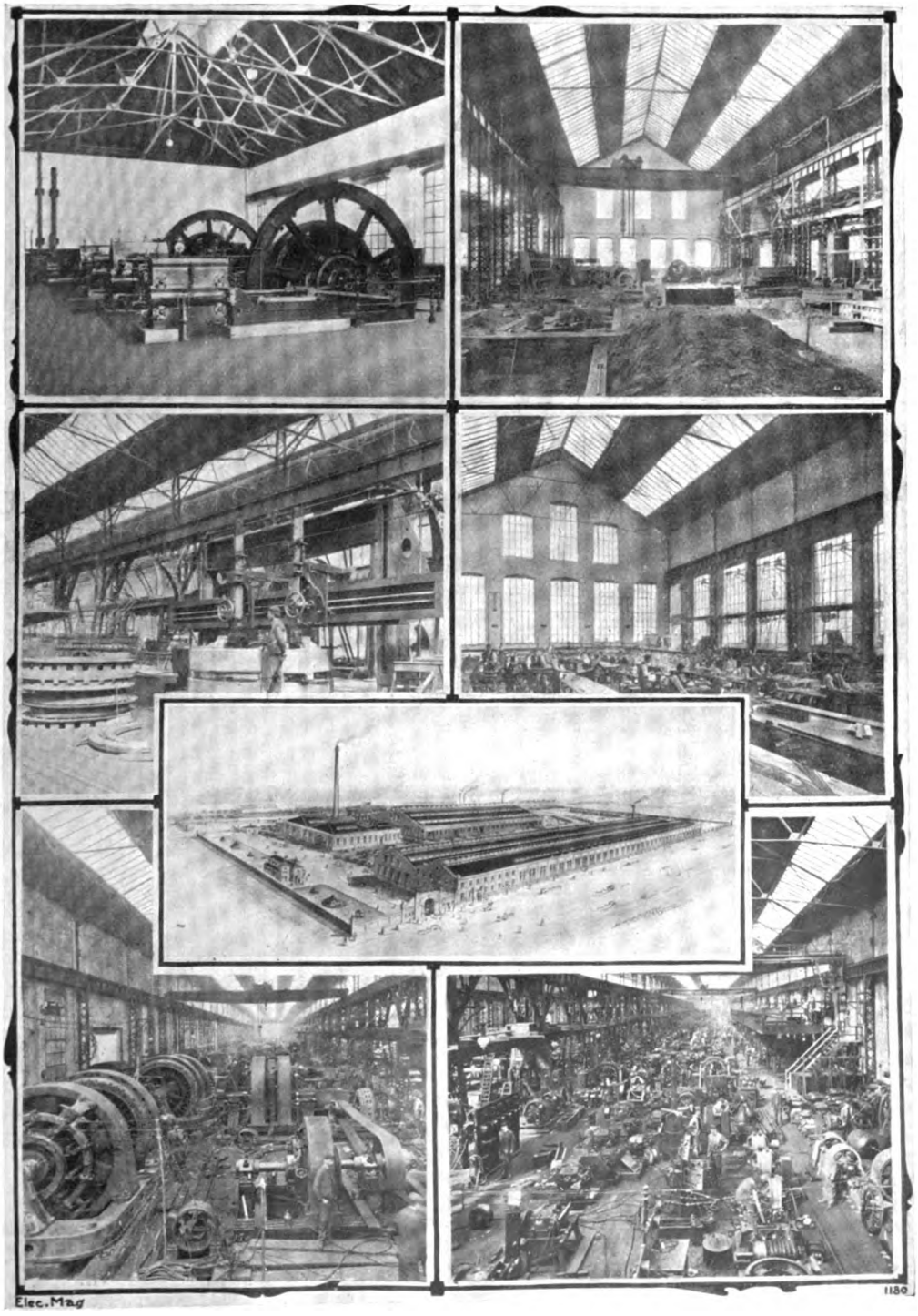
The Foundry Building.—This is 465 ft. long by 120 ft. wide, and is equipped with two thirty-ton cupolas, five brass furnaces, and two fifteen-ton electric cranes. The frames of the largest generators built at the works are cast here, as well as the small brass parts for motors and switch gear. All tools and machines used in the foundry are electrically driven, such as sand-sifters, cleaners, and chipping-tools. The cupolas are fed directly from the railway, and six hundred tons of pig-metal, with enough coke to reduce it, can be stored. An extensive pattern-shop, with large store adjoining, also form part of the foundry building. Modern woodmaking-tools, driven by electromotors, were everywhere in evidence.

The Machine Shop.—This is by far the most imposing of the works buildings, and to both engineer and layman alike presents the chief features of interest. The two bays making up this shop are each 900 ft. long by 60 ft. wide, the dividing-line between them being a double row of lattice-work stanchions, centrally supporting the roof and also carrying the main driving-shaft. This latter is one of the features of the works. To procure the most efficient method of driving, large motors of 50 h.p. each were decided upon. These were each built upon hollow shafts, through which the main shaft could pass to the next length, and fitted with clutches allowing of any motor being stopped independently of the others. A better example of the flexibility of the electric drive for machine-shops would be hard to find.



L.C.C. Sub-Station equipped with Dick, Kerr Converting Plant.

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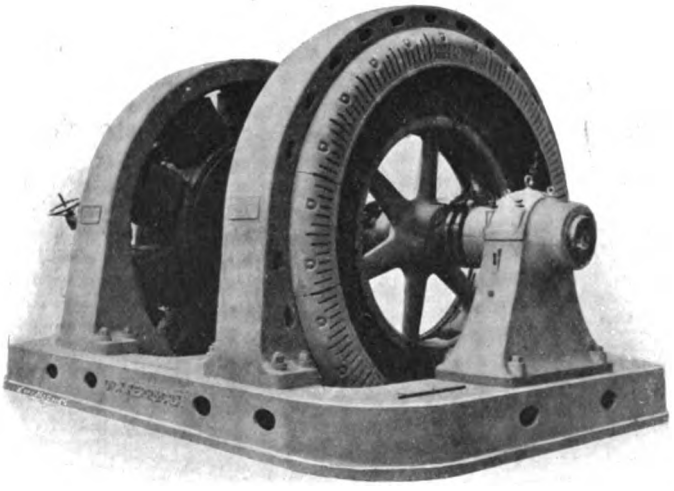
Power House.
Large Boring Mill.
Generator Bay.

General View of Works.

Iron Foundry.
Winding Department.
Motor Bay.

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The work of preparing the raw materials previous to assembly proceeds from the north end of the machine-shop, where the receiving and store department is. This forms the distributing centre for all the different departments, which are supplied with a minimum of delay by the overhead electric travelling cranes. In its passage down the bays the raw material gradually assumes the finished shape, when it is ultimately handled in building up the complete machine. The machine-shop is suitably apportioned into departments for dealing with the various component parts of dynamos, motors,



SYNCHRONOUS MOTOR GENERATOR.

controllers, and switch gear. Of these the most interesting is the heavy machine tool department, where field frames, armature spiders, large shafts, and commutators and stator carcases are dealt with on more or less large lathes, boring mills, planers, slotting and drilling machines, &c. Among these heavy tools we were specially struck with a 24-ft. boring mill and a planer to take a casting of the same length, also a boring and milling machine with a 24-ft. table. Numerous portable tools were also to be seen in operation on large castings, which, for obvious reasons, could be less readily handled than tools which were lightness itself in comparison. Both the generator and motor departments have their own testing plates, which are equipped with every known facility for ascertaining the characteristics of the different types of machines dealt with.

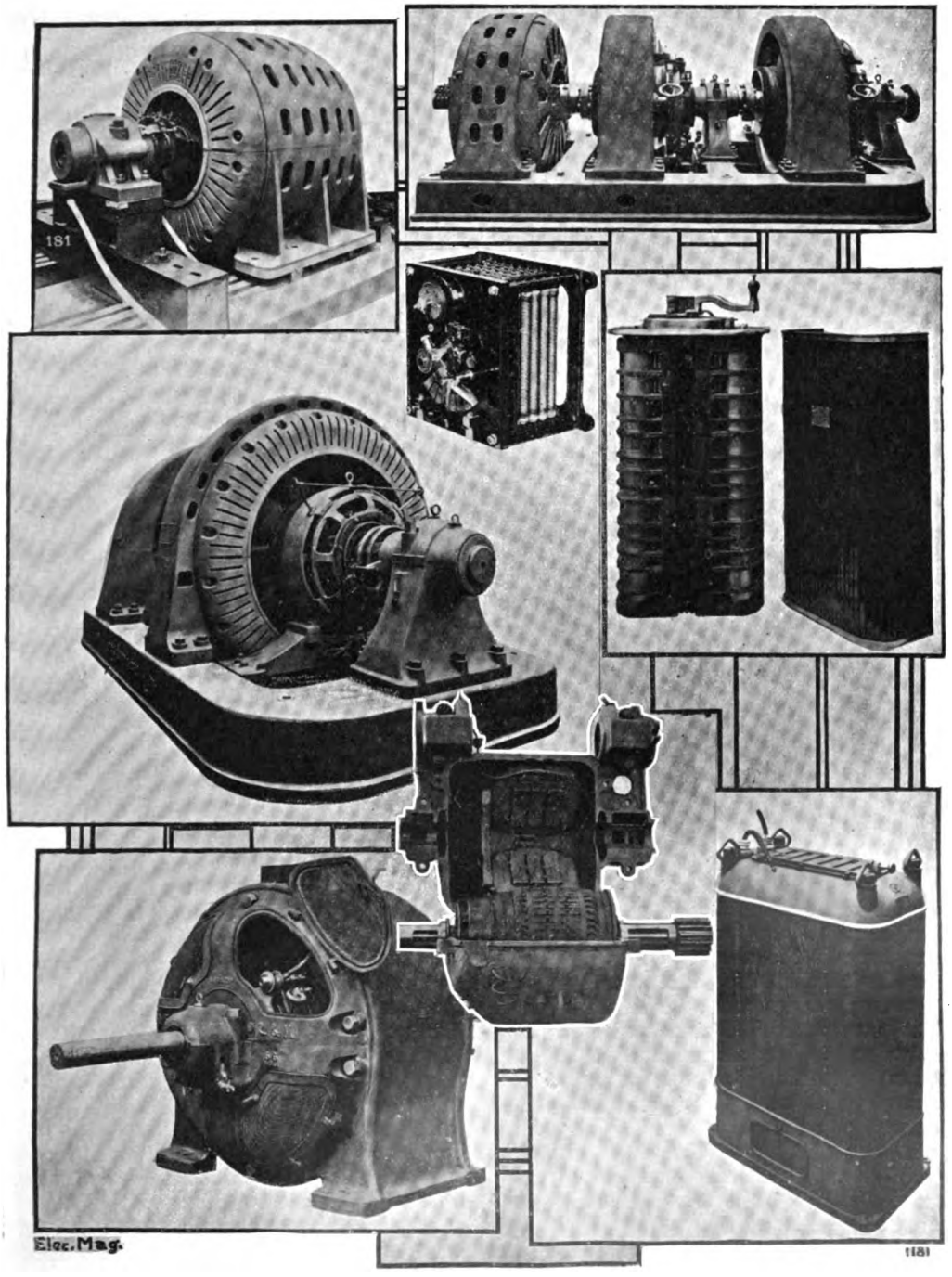
The Power House. — This is a substantial building contiguous with the machine-shop, though originally it was separate from it. The intervening space has, however, been roofed in, and now forms a shop for the winding and transformer departments. The power plant at present comprises two units each of 300 kw. capacity, driven direct by cross-compound Corliss engines of 400 h.p. output, and one 750-kw. unit coupled to a 1,000-h.p. vertical engine. Energy is furnished on the three-wire system at 500 volts. A large battery is held in reserve. Alternate currents of high tension are obtained by motor generator sets, and transformers which give any desired voltage and periodicity.

General. — The arrangement of the works appeared to us entirely conducive to rapid production, ease of handling, and absence of re-handling, material having been well carried out. The employment of small gib cranes further contributed to this speedy treatment of small but heavy parts, and enabled the different operations to proceed with a minimum of waiting upon the overhead crane man. Air lines were laid on in the machine-shop, and high-pressure testing leads were also thoughtfully run to plug-boxes, which reduce the risk of handling conductors at more or less dangerous voltages. For the rest we must leave our readers to judge of the size and equipment of the works, from the photographs published herewith, while we proceed to describe some of their chief products.

ELECTRICAL MANUFACTURES.

The works are laid out for the production of any class of electrical apparatus according to the demands and, one might almost say, the fashions, of the time. In its earlier stages the company chiefly made generators and motors for tramway work, but the former have since been developed on a very large scale into a range of

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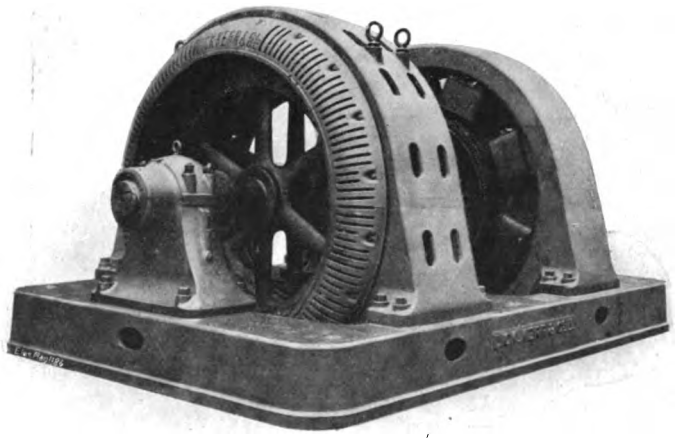
1,500 kw. Turbo-Alternator.
Synchronous Motor Generator.
Standard D.C. Motor.

Standard Motor Starter.
Tramway Motor Open.

Induction Motor and D.C. Balancer.
Large Traction Controller.
Standard Transformer.

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standard sizes both for alternate and direct-current work. The traction motors have been also extended into the field of heavy railway work, and similarly their controlling devices enlarged and adapted. Sub-station machinery, in the shape of motor transformers of all kinds, has in addition been standardised, as have also air-blast transformers and extra high-voltage switchgear. Motors for alternate- and direct-current circuits are built to any size according to the requirements of the purchaser, with them also being constructed the necessary starting and controlling devices.



INDUCTION MOTOR GENERATOR.

Direct-Current Generators.—These represent a fine grade of dynamo electric machines, and are typical of all the work put through the shops. So many have been installed in this country and abroad that our readers must be familiar with their symmetrical design and generous proportions. We understand that the works' capacity for producing these generators is 50,000 kw. per year. The design adopted was that of the late Prof. S. H. Short. The field yoke is circular, with inwardly projecting laminated steel poles, cast integral with the carcase at one and the same time. The field spools are each wound on a steel former, with brass ends which slip over the pole, and are secured by a clamp fitting into dovetails on the end of the pole. A massive cast-iron spider with segmented rim is securely keyed to the engine shaft, and carries the armature core and windings. The former is built up of steel laminations, as is now standard practice, being securely clamped up by machined bolts and massive end rings. The armature coils of copper strip are former wound and, after being insulated with mica, red rope paper and Japanese paper, and dipped and baked, are dropped into the core slots in numbers varying with the size of the machine. A perforated flange on the end ring farthest from the commutator supports the outer ends of the armature coils. The commutator, built up on a separate ring, is securely keyed to the extension of the hub carrying the armature spider. Behind it, and clamped to supports on the end ring, are the balancing rings, which are electrically connected to the commutator at intervals. The brush gear is exceedingly novel, and makes a very neat job of a difficult problem. It comprises a ring of channel section provided with bosses for the brush holders and segmented lugs for the guiding and holding brackets. The channel serves the purpose of carrying the leads neatly to the brush-holder pins, and makes all loose leads an impossibility. Current is led direct to the brush itself without the intervention of hinged joints.

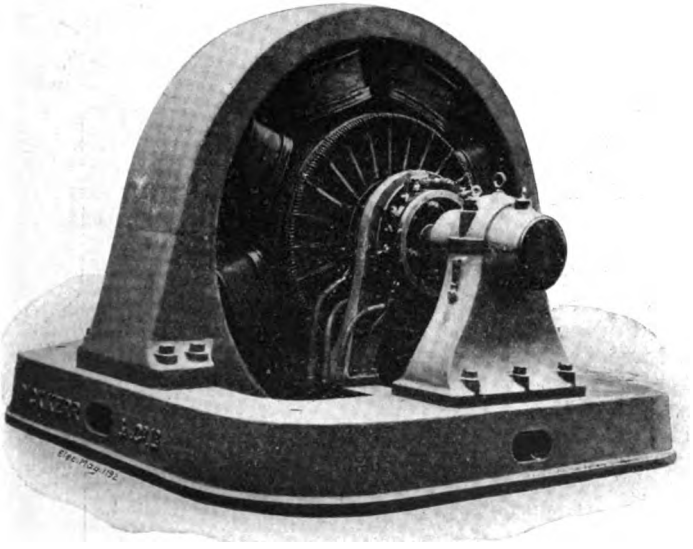
The bed-plate allows of the field system being moved laterally for the purpose of inspecting the armature at any time, without disturbing any of the connections. Before leaving the works all machines are submitted to prolonged tests under full-load conditions, being placed on the testing-plate and coupled up on the Hopkinson method for ascertaining the various losses. The efficiency of the many different sizes passing through the shops is thus carefully obtained and accurately recorded.

These machines have met with an almost universal reception, and are to be found in all the largest tramway power-houses of this country and its colonies.

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Alternate-Current Generators.

A standard line of heavy alternate-current generators has been designed, and machines up to 5,000 kw. for any speed can be made. The machines are all of the revolving field type, and to adequately meet the widely varying conditions of practice several modifications in design have been arranged for. In the rotor, for instance, three types of pole construction are in use, in one dovetailed laminated poles are fixed on the spider rim by cast-iron flanges and machined bolts, the dovetails being also securely keyed.



STANDARD ROTARY CONVERTER.

This arrangement admits of the ready removal of any of the pole-pieces for repair purposes. In another method a cast-steel motor rim is provided on which laminated poles are securely bolted by special bolts engaging with a nut in the pole-piece itself. Another form of construction provides for solid poles of cast-steel bolted to the rim and provided with polar tips of laminated steel. The field coils are wound on edge and insulated between turns with specially prepared fibrous material and mica, their exterior surface is left practically bare, an arrangement which admits of the rapid radiation of the heat. The coils are carried on a thin iron spool heavily insulated at the end, and during the process of winding they are subjected to a very high hydraulic pressure of some hundred tons. The armature core, which is of course stationary, is carried in a cast-iron frame made in either two or four pieces, which are securely bolted together. Ample space is provided for ventilation, and the laminations are built up to admit of a free circulation of air around the armature coils. Either open or partly closed slots are used according to the type of machine. In the first case the coils are former wound, and after careful insulating and drying are slipped into their slots and securely held by wedges. In the partly closed slots the bars are threaded through the slots in a direction parallel to the shaft, the ends being jointed together on the opposite side. The joints are protected and insulated by special caps firmly held in position by neat binding, and a cast-iron shield made up in sections and bolted to the frame protects the coils outside the laminations from damage. This shield is perforated and does not interfere in any way with the ventilation. The ends of the armature coils are brought to insulators and fixed to the lower half of the frame. The general appearance of the machines indicates very careful design and due regard to symmetrical appearance.

Turbo-Alternators.

The appearance of the steam-turbine as a strong competitor to the reciprocating engine has created a demand for generators to run at high speed. This change of policy has not been lost sight of by the company, and already large orders have been procured for machines of considerable output. The revolving field type has been adopted with a four-pole rotor, while the armature is fixed and is wound with coils in partially closed slots. We saw some 3000 kw. machines going through for Glasgow, and understand that machines are in course of construction for Liverpool and other places.

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Sub-Station Machinery.

Every class of rotary transforming apparatus has been standardised and constructed in various sizes. The chief types are rotary converters, synchronous motor generators and induction motor generators. All these are, of course, more or less modifications of the direct- and alternate-current machines described above. When there are no difficulties in the way of starting up the motor generator from the direct-current supply, the company recommend synchronous motors to keep the power factor of the installation as near unity as possible. The rotary converters are very similar to the company's standard direct-current types, but steel frames are used with laminated poles, and tips to decrease the eddy-current losses. Some very important orders for sub-station plant have been secured—notably from the London County Council.

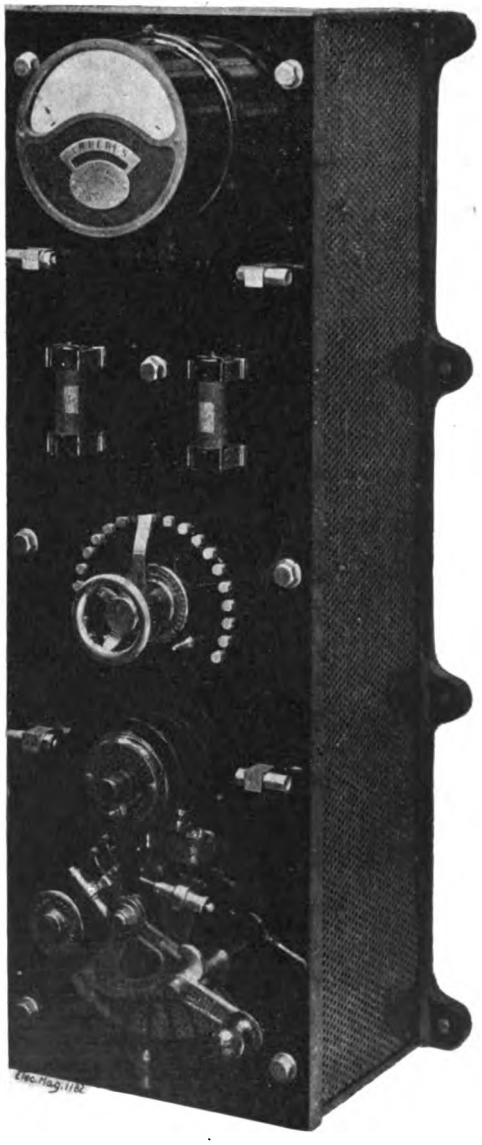
Tramway Motors.

The company has obtained a reputation for tramway motors and car equipment which would be very hard to beat. Many thousands of these machines have been in constant use for a number of years past and are giving entire satisfaction. A feature in their construction is the laminated and ventilated pole-piece, this being built up into three bundles of laminæ provided with projecting horns which serve to hold the field coils in place when the pole-piece is screwed up to the motor carcase. Another feature is the generous proportions of the commutator, this frequently troublesome adjunct to the motor being 11 in. in diameter, and containing 123 tons with a wearing face of 3 in. for the carbon brushes and a maximum of wearing depth of 1 in. By special arrangements the commutator is also accurately centred in respect to the shaft, and consequently always runs straight. We understand that these motors are in use in all parts of the world.

Stationary Motors.

Regular lines of stationary motors for both alternate- and direct-current circuits have also been standardised in sizes from 1 to 100 h.p.

While on the subject of motors we may well refer to a neat starting device which has been adopted. With this it is impossible to start the motor quickly, the controller handle being so arranged that the contact arm is notched up only one step at a time. No matter how quickly the handle is turned, a reasonable time elapses between the switching on of the motor and the cutting out of the starting resistance. Another novel feature is the provision of an effective arc-rupturing device which operates whether the current is broken automatically or by hand.



STANDARD MOTOR STARTER PANEL.

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Tramcar Controllers.

The drum-type controllers manufactured for traction purposes differ from the ordinary types in the method of breaking the arc at each contact. In place of the magnetic blow-out, which has been admitted to be too sharp in its action, a metallic shield interrupter has been fitted which effectively catches and draws out any arc breaking the circuit in a slightly longer time, but much more effectively than does the ordinary magnetic blow-out. The device comprises a circular coil surrounded by a copper tube. A number of these are spaced by insulating washers on an insulated arc, and placed close to the controller contacts. The adjoining illustration indicates clearly the action of the arc at the outset of its travel round the tube. This device has been adopted with complete

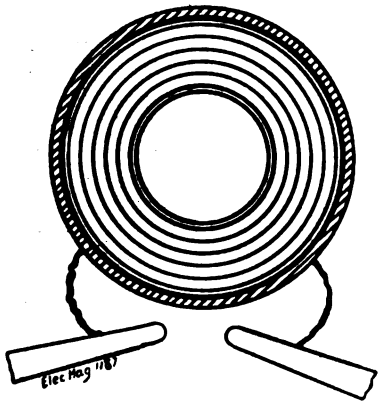


DIAGRAM SHOWING ACTION OF SHIELD BLOW-OUT.

success on the Lancashire and North Yorkshire Railway electrified trams running from Liverpool and Southport. In fact by its use the multiple control of the train motors was rendered possible without the use of complicated unit switch systems. The same device is fitted to standard circuit breakers or direct-current starters, and it is interesting to note that auxiliary contacts are not required, the circuit being broken directly in the magnetic field.

Switch Gear.

Standard types of switching apparatus for controlling both low-tension direct and high-tension alternate currents are manufactured. In the latter class we noticed specially a neat form of high-tension oil circuit breaker which can be controlled either by motor or by links and levers. This type of switch has been standardised for pressures up to 10,000 volts.

Transformers.

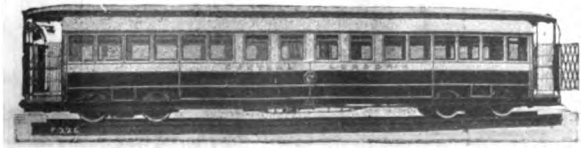
A very neat design of air-blast transformer has been standardised, and is constructed in all commercial sizes, and for pressures up to 10,000 volts.

We illustrate in the preceding pages of photographs types of the various machines described above, and from these our readers will gather the general principles of design which are rigidly adhered to throughout the entire range of machines built.

Conclusion.

The operations of the company extends over a very wide field, and already its products have found place in the most remote parts of the British Empire. It remains to say that Dick, Kerr and Co. are prepared to undertake any electrical scheme, no matter what its magnitude, from the lighting of a town to the equipment of extensive railway systems. It will be gathered from the above brief account of their apparatus that the works at Preston are fully equipped for the manufacture of every class of electrical product in all the known fields of research and design which have so far been broached by workers in electrical engineering.

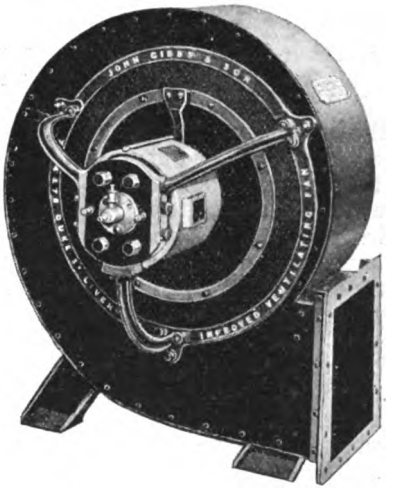
We take this opportunity of extending our thanks to those officials of the company who conducted us over the works and placed at our disposal the data and photographs for the preparation of this article.



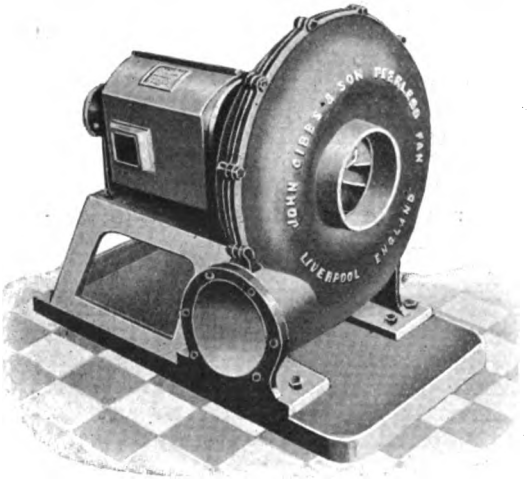
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New Things in Blowers.

THE rapidity with which electric fans and blowers have sprung into popularity is evidence enough of their being good articles and also of their finding appreciative users. A fan or a blower looks a simple enough device, but there is more in the designing and making of either than meets the eye. Research and experiment have been needed in this field before the correct machine has been evolved, and such work could only rest with firms making a speciality of it. John Gibbs and Son, Duke Street, Liverpool, are among the foremost experts in this field, and we are pleased to tell our readers something about their new line of electric blowers.



LARGE PATTERN MOTOR-DRIVEN PEERLESS BLOWER.



MOTOR-DRIVEN PEERLESS BLOWER.

The blowers shown in the accompanying illustrations are of a new type now being manufactured by the above mentioned firm, and with which phenomenal results as regards output in relation to power expended have been obtained. As an instance, we give some particulars of a test recently taken of one of this firm's No. 17 pattern Peerless blower, made for a foreign inquiry, and which we think will be convincing proof of the efficiency of this machine. The air discharged was 2,600 cubic feet per minute whilst maintaining a water pressure of 1½ in., the power taken to obtain this result being 1.75 h.p. The machine was fitted with oil-ring bearings and ran continuously for eight hours

PATTERN.	Revs. per Min.	Working with Free Intake and Free Discharge.			Working against a Constant Resistance on either Intake or Discharge.					Static Water Gauge.						
		Vol. Cub. Ft. per Min.	Vol. Cub. Metres.	H.P.	Pressure Inches of Water.	Vol. Cub. Ft. per Min.	Vol. Cub. Metre per Min.	H.P.	Revs. per Min.	Pressure Inches.	Vacuum Inches.	H.P.	Nett Weight lbs.	Gross Weight.	Nett Weight Kilos.	Gross Weight Kilos.
No. 3. Direct driven by Gibbs' Patent Enclosed Dust Proof Motor	3,400	133	3.76	.24						2¾	3½		98		44.5	
No. 3. Belt Driven	5,300	270	7.64		3	199				7	7½					
No. 6. Direct driven by Gibbs' Patent Enclosed Dust Proof Motor	2,450	1,120	31.71	1.1	5½	550	15.57	1	2,840	8¼	9½	.91	330		140.3	
					1½	661			2,560							
No. 6. Belt driven	2,900	1,450	41.06	2	5½	1,140			3,450	12½	14¾	2.1	128		58	
No. 12. Belt driven	1,000	3,540	100.25													
No. 17. Direct driven by Gibbs' Patent Enclosed Dust Proof Motor	300	2,920	82.69	.46	1.57	2,600	73.63	1.75	650				901		408.8	

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without any attention whatever. These results clearly demonstrate that this machine is one of the most efficient now on the market. The present form of this machine was only arrived at after a number of experiments, and special care was taken in its design to prevent any back-eddies and consequent loss of output. The machines are made in all sizes, from three inches upwards, the smaller sizes being in cast-iron, whilst the larger ones are of steel plate, and can be had either belt-driven or direct-driven by electric motor or steam, as may be desired. The motor-driven blower is fitted with oil-ring bearings and the belt-driven for patent solid lubricant, these arrangements having been found to give the best results. The bearings in both types have been made of ample dimension, and consequently no fear of heating need be apprehended. We understand Messrs. John Gibbs and Sons have been experimenting for some years, but were determined not to put a blower on the market until they were positively assured they could go one better than any previously before the public.

We think, from the enclosed table, they might now justly claim to have done so, the figure in respect of the No. 6 being specially noticeable.

We show two illustrations typical of the various patterns in which these machines are made up, from which it will be seen that lightness and compactness have been kept in view. It will only be necessary for any practical engineer to study the results of the tests made in order to enable him to draw his own conclusions.

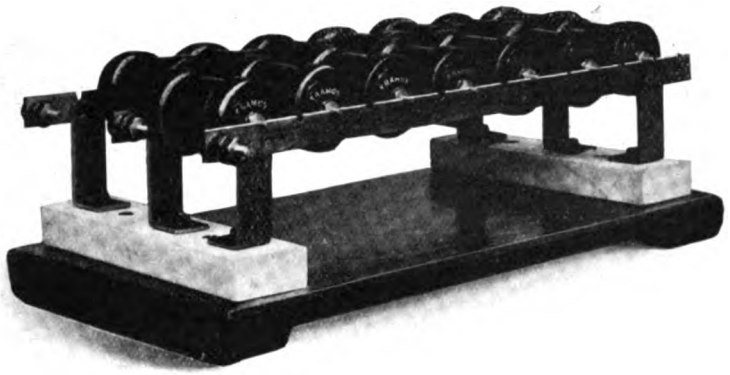


FIG. 1. KRAMOS RESISTANCES ASSEMBLED FOR HEAVY LOAD WORK.

A New Resistance Material.

KRAMOS, Limited, are placing on the market a new resistance material, quite original in composition, structure, and method of production. It is made at their works at Bath, where they have fitted up a plant of specially made tools, including powerful hydraulic presses. Elaborately mixed ingredients are formed into almost a solid body, forming the resistance material. They are in the shape of a cylinder, and consist of two cartridges. The non-conducting mantle surrounds these cartridges, and thus encloses the working parts completely. Around this product, which is treated with heat and damp resisting varnishes, a double cylinder of mica is wrapped and held by a non-metal cap on each end of the cylinder. Brass bolts protrude which are in contact with the inside of the resistance material by a special patented process. All pieces are of the same size: thus a high-resistance piece is no larger than a piece of one ohm resistance, for the resistance of each piece is determined by the nature of the ingredients used. When the current passes it is converted into heat by the resistance cartridges, and the initial heat generated is absorbed by the resistance for a short time and then radiated. The heat generated by a further load will, to a great extent, not be absorbed but will be immediately dissipated. The result is that the heat will be dissipated far more uniformly than the load applied. The power of absorption, together with the large radiating surface, render these resistances exceedingly valuable for intermittent work of any kind.

For alternating currents the Kramos resistances give absolute satisfaction, because they are entirely non-inductive. Each piece can carry a load of 1 kw. for a short time, or a smaller load continuously. The Kramos resistance can be made of any desired ohms between ½ ohm and 300 ohms per piece. If heavily overloaded they will break circuit internally without fusing or burning, hence no damage can be done to the circuit.

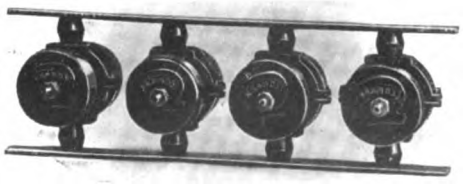
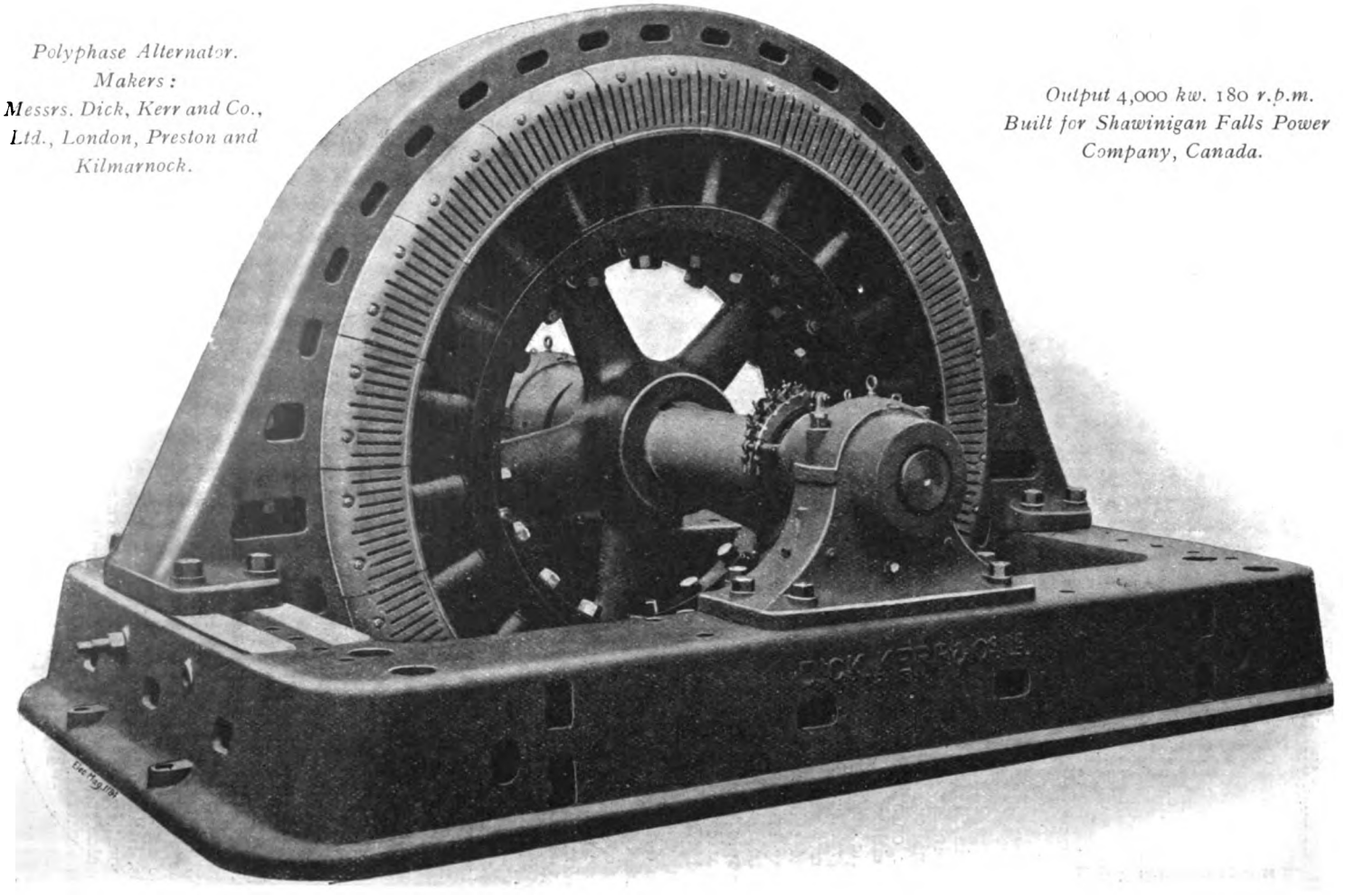


FIG. 2. KRAMOS RESISTANCE FOR HIGH TENSION WORK.

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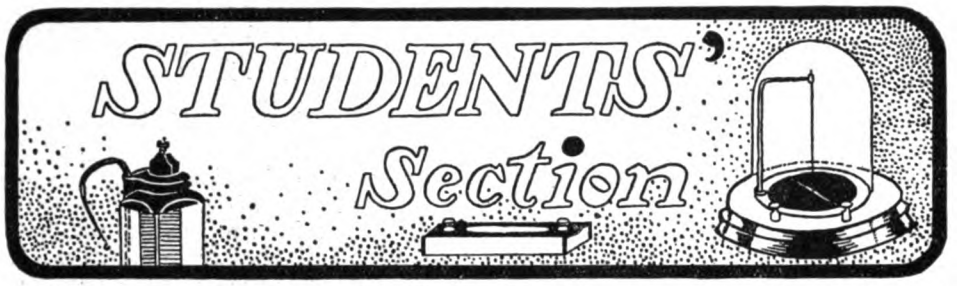
Polyphase Alternator.
Makers:
Messrs. Dick, Kerr and Co., Ltd., London, Preston and Kilmarnock.

Output 4,000 kw. 180 r.p.m.
Built for Shawinigan Falls Power Company, Canada.



Standard Types of Electrical Apparatus. VIII.

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Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

Problems on Distributing Networks.—IV.

By ALFRED HAY, D.Sc., M.I.E.E.

(*Continued from p. 221.*)

Graphical Method of Determining Drop along Distributor Fed from Both Ends.



THE graphical method of solution will be readily understood by supposing the point of lowest potential and the currents x and y flowing towards it provisionally known, and applying the graphical construction already explained in connection with a main fed from one end only (*see* THE ELECTRICAL MAGAZINE, vol. ii., p. 509) to each of the two sections into which the distributor is divided by the point of lowest potential. In Fig. 12 is given the load curve of a distributor fed at F_1 and F_2. Let us assume that the position of L, the point of lowest potential, is known, as well as the values of x and y. Along a vertical line we lay off in succession $i_1, i_2, \ldots i_7$, as shown at the left-hand side of Fig. 12, and, having selected any convenient pole P, join it to the various points of division along the vertical line. The current i_3 branches off at L, and in the left-hand or current diagram the line representing i_3 is divided into the two sections x and y, and the point of division joined (by a dotted line) to the pole. Starting now from any point f_1 vertically below F_1, we draw lines parallel to the various lines radiating from the pole in the current diagram, as far as the current x, thereby constructing the open link polygon $l' f_1 l$ for the distributor F_1 L, which is fed at one end only. By what has already been explained in an earlier article, ll' represents to a certain scale (depending on the distance of P from the line of currents) the drop from F_1 to L.

Similarly, starting from any point ϕ_2 vertically underneath F_2, we construct the open funicular polygon $\phi_2 \lambda\lambda'$, in which $\lambda\lambda'$ represents the drop from F_2 to L.

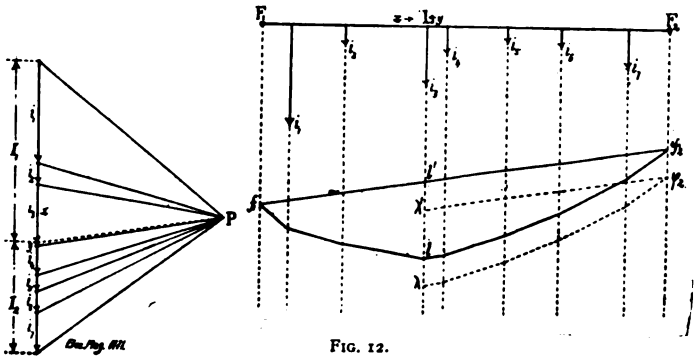


FIG. 12.

Now since the drop along F_1 L equals that along F_2 L, we must have $\lambda\lambda' = ll'$. The position of ϕ_2 being immaterial, so long as it is on the vertical through F_2, we may imagine the polygon $\phi_2 \lambda\lambda'$ displaced parallel to itself until λ falls on l, and λ' on l'. Then since both $f_1 l'$ and $f_2 l'$ (the new position of $\phi_2\lambda'$) are parallel to the dotted line in the

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current diagram, $f_1 l' f_2$ is a straight line. Thus the combination of the two open polygons corresponding to F_1 L and F_2 L gives rise to a single *closed* polygon, and the side $f_2 f_1$ of the polygon is parallel to that line in the current or polar diagram which divides the current at the point of lowest potential into the two portions x and y. The method of construction now becomes evident, and is as follows: Using the load diagram, construct the corresponding polar diagram, having selected a convenient position for the pole. Starting from any point f_1 vertically underneath F_1, draw in succession lines parallel to those radiating from the pole, thereby constructing the open polygon $f_1 l f_2$. *Close* this polygon by joining $f_1 f_2$, and in the polar diagram draw a line from P parallel to $f_2 f_1$. The intersection of this line with the line of currents gives x and y, while the vertical depth $l l'$ at the corresponding part of the funicular polygon gives the drop. Further, the two segments I_1 and I_2 into which the entire line of currents in the polar diagram is divided by the dotted line, are the currents supplied to the distributor at F_1 and F_2 respectively. As in dealing with the open funicular polygons obtained with distributors fed at one end only, we may speak of the portion $f_1 l f_2$ of the funicular polygon as the *branch-current line*, and of $f_1 f_2$ as the *supply-current line*. The load diagram for which the construction of Fig. 12 has been carried out is identical with that of Fig. 10, for which we have already obtained the solution by an algebraical method.

Single Distributing Mesh Fed at One Point.

In the case of a closed distributor such as that shown in Fig. 13, fed at a single point, the solution is easily obtained by applying the above methods. We have only to imagine the distributor and feeder split open at the feeding-point, and the distributor, which formed a mesh, now becomes a simple length of distributor fed at both ends, as shown in Fig. 14.

Distributing Network Fed at a Single Point.

Next in order of complexity is the case of a number of intersecting distributors forming a network of several meshes, such as the one shown in Fig. 15, and fed at a single point F. There will in this case be, in general, a number of points of least P.D., and the method employed in connection with a single distributor fed from both ends may, with a certain modification to be indicated presently, be extended to this case also. The modification consists in arbitrarily assuming the positions of *a number* of points of lowest potential. The number of such points and their positions must be so chosen that if the distributing network be cut at the assumed points of lowest potential, there will no longer remain any closed

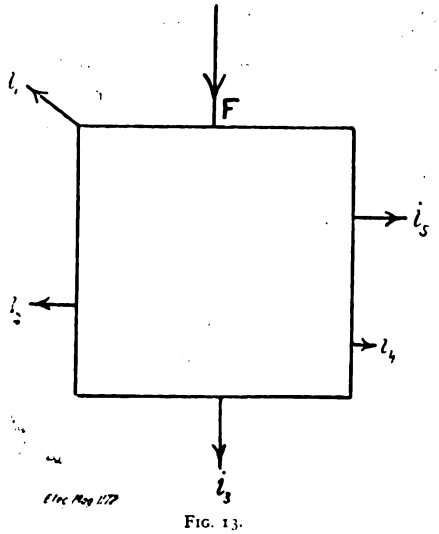


Fig. 13.

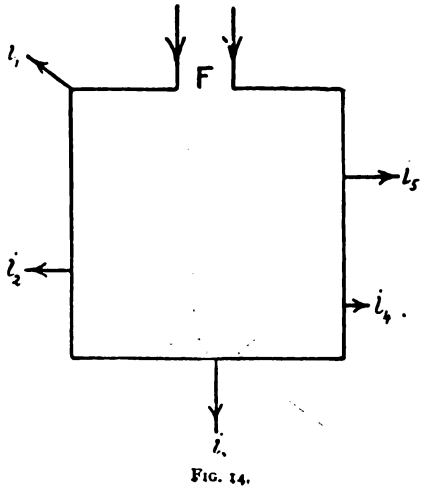


Fig. 14.

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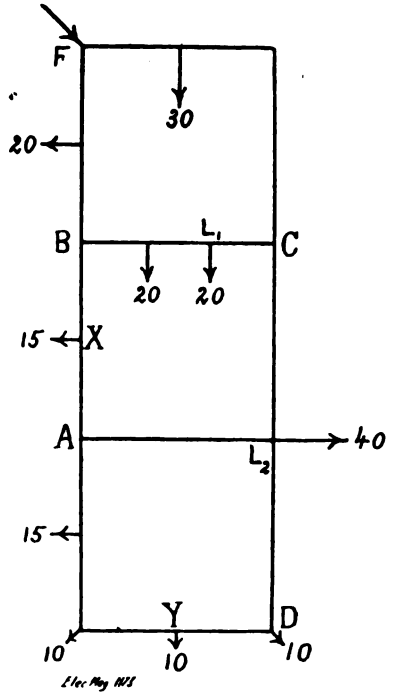


FIG. 15.

meshes. At the same time, each portion of the cut network must remain in connection with the feeding-point. In the most general case, in order to open a network of *n* meshes, *n* cuts will be necessary; hence there must be *n* assumed points of lowest potential. Frequently, however, a smaller number of such points will suffice. For if an assumed point of lowest potential be chosen at a node of the network, such as the point L_2 in Fig. 15, then the result of cutting the distributing network at this point is to open more than one mesh (in the case shown in Fig. 15, two meshes will be opened —*see* Fig. 16). Subject to the conditions stated above, the choice of the number and positions of the assumed points of lowest potential is quite arbitrary, any convenient assumption leading to a correct solution. But the labour of the calculation may, in many cases, be materially reduced by a judicious choice.

The method* will be best understood by a careful study of the example shown in Fig. 15, where we have a network of three meshes fed at F, the problem being to determine the distribution of the currents in this network. We might assume three points of lowest potential, such as the points L_1, X, and Y. Cutting the network at these points would open all the meshes, at the same time leaving every portion of the network connected to the feeding-point. We should then, as in the case of a single length of distributor, introduce as our unknown quantities the currents which meet at every assumed point of lowest potential. Since the sum of any two currents (such as the currents *x* and *y* at L_1) is known, being equal to the current (20 amperes) leaving the network at the same point, we get one relation connecting the pair of unknown quantities corresponding to each assumed point of lowest potential. A second relation is obtained by expressing the fact that the drop along each of the two paths leading from the feeding-point to an assumed point of lowest potential is the same. We should thus, by assuming L_1, X, and Y as the points of lowest potential, be led to a system of six equations involving six unknown quantities. Now by selecting the point L_2, which is a node of the network, as a point of lowest potential, we open *two* meshes by an incision at a single point. Since, however, there are three conductors meeting at L_2, there will be three unknown currents flowing towards it, necessitating the introduction of three unknown quantities into our equations. By choosing the two points L_1 and L_2, we obtain a system of five equations involving five unknown quantities, instead of the six equations corresponding to L_1, X, and Y.

* The development of this "Section-Point Method" is due largely to Herzog and Feldmann.

We shall be delighted *to see you at the Holborn and Finsbury Electrical Exhibition of the County of London Electric Supply Co. Ltd. The Exhibition rooms are 118–122 Holborn, and you will find us at Stand No. 42, in the basement.*

Next month *we shall publish an important article, "The Training of Engineers," by Harold H. Broughton.*

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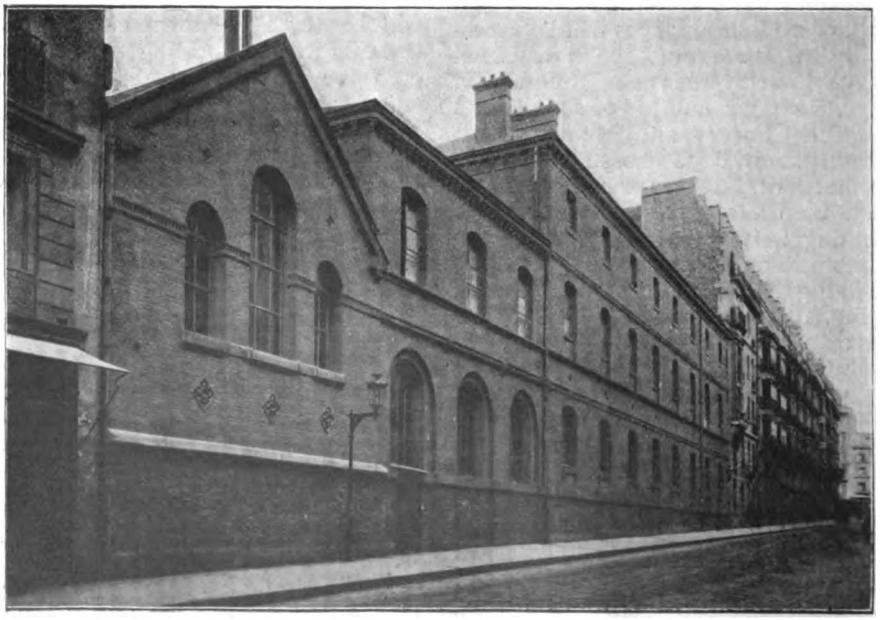
Paris Ecole Supérieure d'Electricité.

By J. GARCIN.

THERE are but few electrical institutes in France. In such schools of technology as the Ecole Centrale or the Ecole Polytechnique, instruction in electricity forms part of the curriculum, and engineers from these schools are supposed to have acquired sufficient general knowledge to be able to turn their attention to any branch of engineering. Until quite recently the idea that electricity was of sufficient intrinsic importance to be considered as a separate branch requiring special training and early specialisation had not gained ground. The steady growth of electrical applications, however, soon rendered it imperative for would-be electrical engineers to look for some less superficial method of instruction, and about fifteen years ago the Ecole Supérieure d'Electricité was instituted with a view to specialising those who had already been through the general engineering course.

The school was founded by the Société des Electriciens, and its buildings are contiguous to those of the Laboratoire Central d'Electricité, which belongs to the same Société. The school buildings, three storeys high, extend over an area of 520 square metres. On the ground-floor are the school laboratory (140 square metres) and dynamo-room (180 square metres), the workshop being in a separate building known as the Pavillon Giffard, comprising ground and first floor. On the first floor of the main building are the lecture-room, the Sub and Workshop Directors' studies and several rooms reserved for special testing work. On the second floor are fifteen small studies, each containing a drawing-table, blackboard, and cupboard, in which the students are at liberty to prepare the subject-matter of the lectures. The engine-room is a fine glass-roofed building, containing both continuous- and alternate-current machinery, a reserve source of power being a battery of Blot accumulators of 250 a.h. capacity and two transformers, each of 15 kw., fed by the Secteur de la Rive Gauche (monophase 420 cycles).

Though the school claims to be, and is, in many respects, very practical in its methods of tuition and training, yet the theoretical instruction given to its students is of the very highest order. It is now universally recognised on the Continent that an electrical engineer



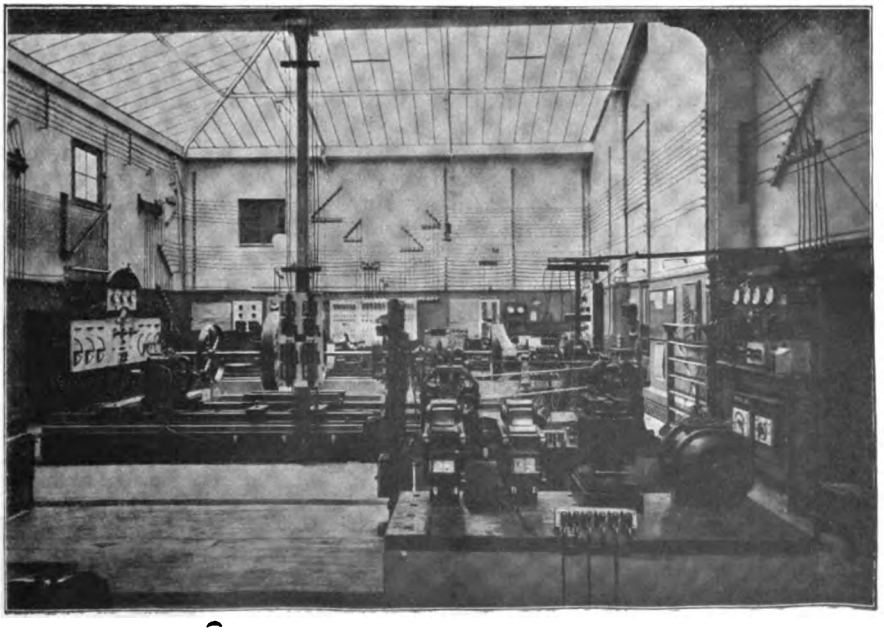
ECOLE SUPÉRIEURE D'ELECTRICITÉ. EXTERIOR OF MAIN BUILDING.

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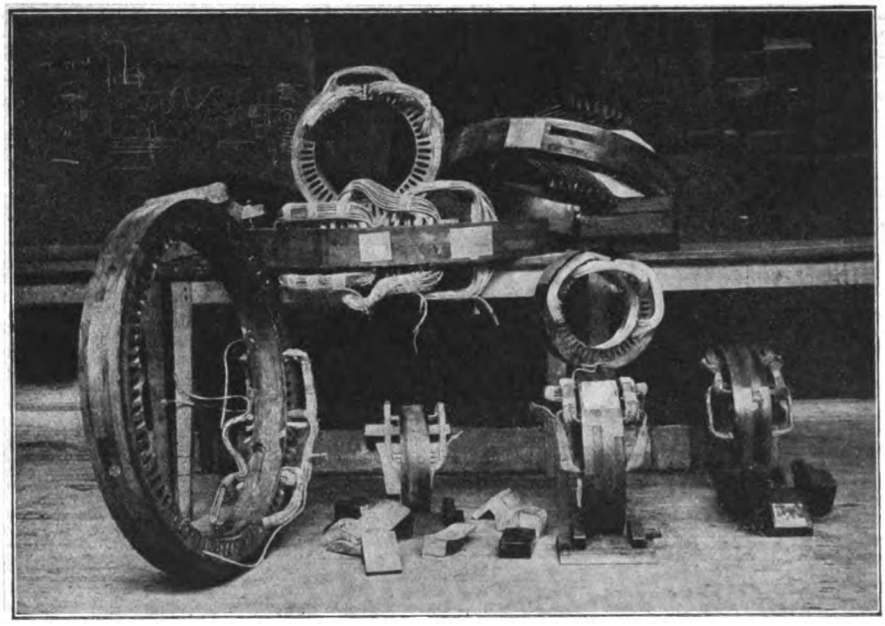
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should be well versed in mathematics, physics, and chemistry. In accordance with this idea the instruction is divided into two parts, one comprising courses of lectures on all electrical subjects and the other a general course of practical exercises through workshops, laboratory, and demonstrative work. The lecture courses take up the early part of every day in the first half-year, while practical



VIEW IN DYNAMO LABORATORY.

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WINDINGS EXECUTED BY STUDENTS. ECOLE SUPÉRIEURE D'ELECTRICITÉ.

work (laboratory trials and tests, and workshop) occupy every afternoon in the first half-year and every day in the second. In addition to the ordinary lectures, competent specialists are engaged to deliver lectures on subjects of their speciality, there being on the average six of these extra lectures per week.

The laboratory exercises are of two kinds, comprising accurate experimental measuring, and calibrating, the object of which is to train the mind of the student so as to enable him to form a rapid opinion as to the accuracy of any method, and industrial testing work such as standardising, tests of steel and iron, &c. In this latter department the student is taught to use his inventive faculties so as never to be taken at a loss when a difficulty springs up. An electrical engineer should be able to turn anything at his disposal into an instrument for measuring; to misquote an old saying of Faraday's, he should be able to measure current intensity with a thermometer and temperature with an ammeter. Another feature in this college is the special attention devoted to workshop and other manual exercises, which are very much neglected in other French institutes. The subject of continuous-current windings has just lately also been taken up very specially. the students being taught to execute different forms of windings on wooden armature models, after having worked out the necessary diagrams and calculations. A similar plan is adopted with regard to the construction of commutators. The workshop is well fitted up with suitable machinery, the motive power being supplied by two electro-motors of 4 h.p. each, which are fed at 110–160 volts by current from the local battery.

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The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. Consult it and save yourself much valuable time.

Statistics of the Growth of Electricity Supply Stations.

By W. POLLARD DIGBY, F.S.S., A.M.I.E.E.



IN an eloquent passage referring to the services which Dr. Gilbert of Colchester rendered to the foundation of the study of electricity as a science, Professor Silvanus Thompson declared that whereas there were dramatists before Shakespeare, statesmen before Burleigh, adventurers before Raleigh, before Gilbert there were no electricians. If it be permissible to parody (of course, not in a humorous light) the words of a past President of the Institution of Electrical Engineers, the writer would like to observe that there were inventors before ——, directors before ——, capitalists before ——, even vexed and perturbed shareholders before those who recently voiced their discontent at an annual meeting of the —— Manufacturing Co., but before Garcke there were no statisticians of the electrical industries. The fault of most sweeping assertions, that they are general rather than precise, would apply in a slight degree to an asseveration of this character. A popular —the adjective is used in no invidious sense—weekly electrical paper had earned a wide repute for its tables of costs of electricity supply even before the appearance of the celebrated *Manual of Electrical Undertakings*, which now, swollen in volume, typifies by its increasing bulkiness no less than by its increasing circulation the steadily increasing electrical industry. While certain information was common to the pages of both the annual and the weekly publications, the former made, and still makes, a special appeal by reason of its elaborate returns of aggregate capital invested in various directions quite beyond the scope of the latter, not only in electricity supply and traction, but in manufacturing and allied undertakings. By reason of this, no less than by reason of the tables given of the totals for the individual years, the writer has to acknowledge his indebtedness to the several volumes of this *Manual* for many of the figures quoted in this article. Of the figures now advanced for the first time, it can only be said that they are based on the figures given in the *Manual*, and while not absolutely complete serve to indicate certain broad distinctions between the financial side of the two groups of electricity supply undertakings.

As regards the total capital invested in regard to electricity supply companies, this covers share and debenture capital, while in respect to municipal undertakings the capital invested actually represents the authorised loans required for their construction.

Table I. shows in a more ready form the relation between the relative importance of the two classes of undertakings. Whatever may be said of municipal trading, it has proved a good friend to the electrical manufacturing

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TABLE I.—CAPITAL INVESTED IN ELECTRICITY SUPPLY UNDERTAKINGS.

Year ending Dec. 31.	Companies.		Municipalities.		Total.	
	Number making return.	Capital.	Number making return.	Capital.	Number.	Capital.
		£		£		£
1896	38	5,831,073	33	1,967,000	71	7,798,073
1897	58	6,647,792	57	3,509,317	115	10,157,109
1898	70	8,407,628	93	5,734,938	163	14,142,566
1899	87	9,265,793	124	8,531,167	211	17,796,960
1900	108	12,434,827	169	13,776,372	277	26,211,199
1901	142	18,553,390	192	19,165,495	332	37,718,885
1902	157	21,566,190	213	23,427,410	370	44,993,609
1903	170	24,457,352	241	27,794,452	411	52,251,804
1904	183	30,341,735	262	31,619,578	445	61,961,313

industry. In 1901 the capital invested in municipal undertakings first exceeded that in undertakings due to private enterprise. Unless there be a check on municipal trading, it seems probable that the margin between the two classes of undertakings is likely to be an increasing one, despite the growth of large power companies supplying electricity in bulk to various consumers.

In Table II. is given an analysis of sundry factors concerning central stations owned by companies, while Table III. gives similar information in regard to municipality electricity supply undertakings. In place of analysing each table separately, they are best contrasted by taking the figures pertaining to the same factors from the tables, combining them in the form of curves, as given in the succeeding diag ams. One difficulty requires to be countered at the outset. While it is possible to ascertain the subscribed capital or the amount of the authorised loans devoted to electric lighting from practically every station, the returns as to lamp connections or units sold do not come from so many cases. Very often a new station is opened before the end of the period covered by the *Manual* of any year, but returns as to units sold or lamp connection have to await the end of the undertaking's financial year. On that account the returns as to lamp connection and the number of units sold apply in almost every case to a less number of works than do the returns as to capital.

Dealing first of all with the number of lamps connected, Diagram II. depicts both the increase in connections as a whole, as well as the number connected per station. The aggregate connections to the municipal stations did not exceed those connected to company-owned stations until after 1899. The average connections per station have been subject to considerable fluctuation in the case of the returns from the stations owned by companies. In 1896 nearly all the large supply undertakings were in the hands of companies, and the initial figure in this connection of an average of 50,614 lamps connected per company-owned station for twenty-seven underakings in 1896 may be contrasted with an average of 51,150 lamps per company-owned station for one hundred and forty-two undertakings in 1904. The increasing number of new stations has tended to keep down the average from this class of stations. The returns, of course, include not only those of really old installations, but also those of newly opened installations in their first or second year of working. The average lamp connections in the municipal stations making returns have advanced fairly continuously from 20,146 lamps per station for thirty-three stations in 1896 to 51,411 lamps per station for 247 stations in 1904.

Diagram III. deals with the total number of units sold in the two classes of stations, the number per station, and the number of units sold per lamp connected. The total sales were greater from the company-owned stations, and remained in excess of the total sales from the municipally-owned stations until after 1899.

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TABLE II.—COMPANY-OWNED ELECTRICITY SUPPLY WORKS.

Year ending Dec. 31.	Aggregate subscribed capital.	Capital per station.	Lamps connected in 8 c.p. equivalent.	Lamp connections per station.	Units sold.	Units sold 000's per station.	Units burned per 8-c.p. lamp connected, i.e., units sold per station ÷ lamps connected per station.	Capital invested per station.	
								Per 100 8-c.p. lamps connected.	Per 1,000 units sold.
	£	£							
1896	5,831,073 (38)	153,449	1,366,582 (27)	50,614	20,566,128 (27)	761.7	13.7	303.2	201.4
1897	6,647,792 (58)	114,617	1,730,474 (39)	44,371	25,465,302 (34)	749.0	16.9	258.3	153.0
1898	8,407,628 (70)	120,109	2,368,102 (49)	48,357	32,964,125 (39)	845.3	17.4	248.3	142.1
1899	9,265,793 (87)	106,504	2,943,297 (70)	42,047	42,672,341 (41)	1040.8	24.7	253.4	102.3
1900	12,434,827 (108)	115,138	3,607,923 (87)	41,470	56,883,927 (82)	693.8	16.7	277.6	165.9
1901	18,553,390 (142)	130,658	4,648,814 (110)	42,262	71,209,691 (107)	665.5	15.8	309.2	196.3
1902	21,566,190 (157)	137,364	5,023,534 (99)	50,732	84,404,279 (92)	917.5	18.1	270.8	149.7
1903	24,457,352 (170)	143,866	6,811,778 (142)	47,970	111,296,056 (130)	856.9	17.8	299.5	167.8
1904	30,341,735 (183)	165,800	7,263,239 (142)	51,150	137,085,473 (142)	965.3	18.8	417.7	221.3

TABLE III.—MUNICIPALLY-OWNED ELECTRICITY SUPPLY WORKS.

Year ending Dec. 31.	Aggregate subscribed capital, i.e., authorised loans raised for electric lighting.	Capital per station.	Lamps connected in 8 c.p. equivalent.	Lamp connections per station.	Units sold.	Units sold 000's per station.	Units burned per 8-c.p. lamp connected, i.e., units sold per station ÷ lamps connected per station.	Capital invested per station.	
								Per 100 8-c.p. lamps connected.	Per 1,000 units sold.
	£	£							
1896	1,967,000 (33)	59,600	664,816 (33)	20,146	9,637,638 (33)	292.0	14.5	295.9	204.1
1897	3,509,317 (57)	61,567	1,218,835 (50)	24,376	17,837,874 (48)	371.6	15.4	253.0	165.6
1898	5,734,938 (93)	61,666	1,738,625 (63)	27,566	27,161,351 (56)	485.0	17.6	223.3	127.1
1899	8,531,167 (124)	68,800	2,716,586 (88)	30,870	42,476,726 (64)	663.7	21.5	222.5	106.6
1900	13,776,372 (169)	81,517	4,052,465 (114)	35,545	68,232,688 (111)	614.7	17.3	229.3	162.4
1901	19,165,495 (192)	99,820	5,787,205 (168)	34,448	125,232,043 (151)	829.3	24.0	289.8	120.4
1902	23,427,410 (213)	114,682	7,836,187 (197)	39,777	162,505,417 (178)	912.9	23.0	287.9	125.6
1903	27,794,452 (241)	115,329	10,247,786 (221)	46,370	233,216,580 (226)	1031.9	22.3	248.7	111.7
1904	31,619,578 (262)	120,685	12,708,196 (247)	51,411	310,992,584 (238)	1306.7	25.4	249.1	101.0

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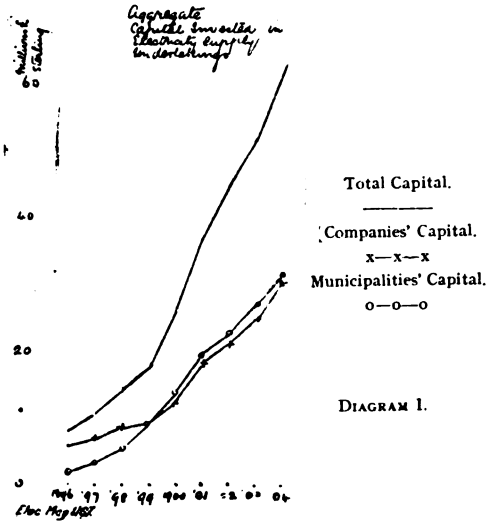


DIAGRAM I.

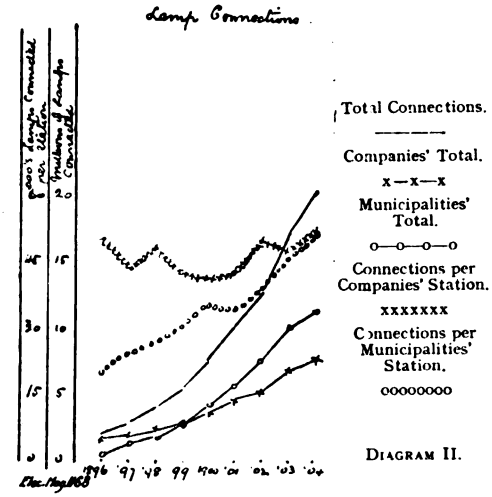


DIAGRAM II.

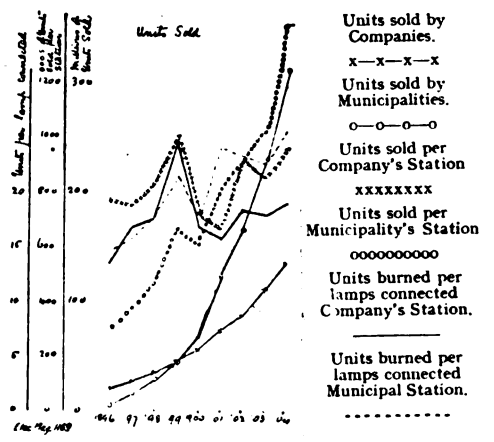


DIAGRAM III.

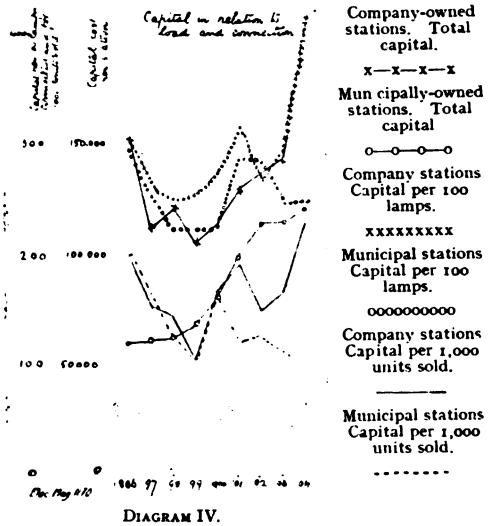


DIAGRAM IV.

The average units sold per station were initially very much greater in the case of the company-owned undertakings, the average being 761.7 thousand in 1896 and 965.3 thousand in 1904. On the other hand, the average units sold per municipal station have increased from 292.0 thousand to 1306.7 thousand per station in 1904. As regards the watts burned per lamp, the curves for both sets of stations moved in close sympathy until 1900, when the consumption in the municipal stations exceeded that in the company-owned stations.

Diagram IV. depicts the various relative movements of the capital invested in its average for each of the two classes of stations, and in its relation to the lamp connections and the units sold. So far as the capital invested per station is concerned, this is tending towards a greater parity. Standing at £153,449 per company-owned station in 1896, the average value now is £165,800. On the other hand, the capital cost per station for municipal undertakings has increased from £59,600 in 1896 to £120,685 in 1904. Contrasted with the steady rise in this section, the capital cost per company-owned station fell with 1899. The recent rise is in part due to the extensions of existing works and also in part to the fact that the undertakings supplying power in bulk fall within the category of private rather than of public enterprises.

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With regard to the capital cost reckoned in its equivalent per 100 lamps connected and per 1,000 units sold, it must be remembered that arc lamps used for street lighting are reckoned in their 8 c.p. equivalent, and that the units sold include power for traction undertakings in regard to which the only seven companies, one in London and the rest in the provinces, have traction loads, while sixty-five municipal authorities supply power for this purpose. The inclusion of this load, therefore, gives an unduly low value in the case of the municipalities of the capital invested per 100 lamps connected, and an unduly high value for the units burned per lamp connected. In each case also the private motor load is included in the current sold per lamp connected. To review the position of electricity supply, as a whole, is therefore a matter of some difficulty on account of these factors. A perusal of several volumes of the Garcke *Manual*, or several issues of the *Electrical Times*, will give the history of any individual undertaking in profuse detail. Reckoned as a whole, a few comparisons may be given as to what this vast expenditure of nearly £62,000,000 sterling has involved. Of this sum, roughly 42 per cent., or about £26,000,000, has been expended on generating machinery (boilers, engines, dynamos, &c.), meters, and switchboards, while 34 per cent., or about £21,000,000 sterling, has been expended on mains, including, of course, their laying. Quite apart from other demands for motors, lamps, fittings, and complete equipment for isolated plants, this is by no means a small achievement. If we reckon also the lamp connections as having cost the consumer about twenty shillings per point, there has been incurred in this manner in nine years an expenditure of about £20,000,000, much of which has gone on labour, but part of which has thrown further demands on the manufacturer of smaller wires, casings, or other covering, switches, lamps, holders, and such goods.

Unless an electrical census be taken, it is difficult to estimate the number of men who find employment in the actual working of supply stations. Reckoning, however, that for each unit sold 0.62 pence are expended on salaries and wages, nearly 1¼ millions sterling was distributed in electricity supply works alone in this manner in 1904. Other comparisons might be made, but sufficient has probably been said to indicate the tremendous importance of electricity supply, in regard to whose activities and growing applications no signs of diminution have manifested themselves. An increase in nine years of 700 per cent. in capital, of 1,000 per cent. in lamp connections, and of 1,400 per cent. in the units sold is, for an undertaking of such industrial and financial magnitude, without parallel save as regards electricity supply in the United States.

STEAM RAISING FROM DESTRUCTOR PLANTS.

MR. W. P. ADAMS' recent paper before the Institution of Electrical Engineers, followed by Mr. C. E. Stromeyer's interesting report of test carried out at Nelson, which has just appeared in various technical journals, has undoubtedly served to emphasise the value of the refuse destructor in power production. It will be agreed that the conclusions to be drawn from the former, and the attempt to calculate the chemical composition of the fuel, as contained in Mr. Stromeyer's report, are, to say the least, most instructive, and certainly afford ample scope for discussion and further analysis. We have just received some additional information, bearing on the performance for a period of five weeks, of the plant reported on by Mr. Stromeyer, namely, from January 2 to February 4 inclusive, and the general results may be taken as confirming the figures obtained some two years before. It is, of course, fairly well known that the calorific value of towns' refuse varies in different districts and at different seasons. We are pleased, therefore, to be in a position to place before our readers figures which will enable them to estimate the comparative value of London and Lancashire refuse. The National Boiler and General Insurance Company, Ltd., in March last, carried out a test on the plant erected for the Metropolitan Borough of Woolwich at their combined destructor and electricity works, and we append figures herewith from Mr. Edward G. Hiller's report. Taking Mr. Stromeyer's figures for the Nelson plant, the average evaporation per pound of fuel for the two days on which the test extended was 1.787 lbs. of water, from and at 212° Fahr. Mr. Hiller's figures for the twenty-four hours' test at Woolwich were 1.917 lbs. of water, from and at 212° Fahr. per pound of fuel. It should be pointed out, however, that the plant at Nelson is not equipped with the economising accessories possessed by the Woolwich plant. At the former there is no economiser and no superheater, but

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even allowing for their absence we are inclined to think that, during the winter months at any rate, there is not the material difference in calorific value between North Country and London refuse, as is commonly supposed.

RESULTS OBTAINED DURING FIVE WEEKS' RUN OF REFUSE DESTRUCTOR, NELSON, JAN. 2 TO FEB. 4, 1905.

Furnaces containing 100 square feet grate area heating one Lancashire boiler, 30 ft. by 8 ft.

Weight of refuse destroyed, 781 tons, 16 cwt. 2 qrs.		
,, ,, ,, . .		1,751,288 lbs.
Water evaporated, 337,612 gallons =		3,376,120 ,,
,, ,, per lb. of refuse actual . .		1.927 ,,
,, ,, per 1 lb. of refuse from and at 212° F. . .		2.12 ,,
Average temperature of feed water entering boiler		150° F.
Average steam pressure . .		130 lbs.
Destructor steam blowers open .		391 hours
Steam supplied to electricity works		346 ,,
Mortar mill running . . .		100 ,,
Electricity generated:		
Traction . 25,099 units		
Lighting . 7,700 ,,		32,799 units
Per ton of refuse (average, including banking) . . .		42 ,,
Maximum, per ton of refuse .		104 ,,
Per hour of steam supply (av.)		94.8 ,,
,, ,, ,, (max.)		208 ,,

Water measured through Kent's Absolute Hot Water Meter.

N.B.—Besides the power supplied to the electric light and power station, as above, the destructor provided steam for: Disinfector, baths and lavatories, pumps, steam kettle and cooking-pans clothes-drying closet, hot water to stables, steam-heating of provender room and disinfector buildings.

RESULTS OBTAINED AT WOOLWICH ELECTRICITY WORKS ON MELDRUM REFUSE DESTRUCTOR, MARCH 29-30, 1904.

One Babcock and Wilcox boiler with 1,827 square feet heating surface.

Deductions.

Weight of refuse fired per square foot of grate per hour	77.4 lbs.
Feed water evaporated per lb. of refuse	1.637 ,,
Equivalent evaporation from and at 212° per lb. of refuse (boiler, superheater, and economiser combined) .	1.917 ,,
Equivalent evaporation from and at 212° per lb. of refuse (boiler and superheater only)	1.797 ,,
Boiler pressure	195 ,,
Electrical output . (B.O.T. units)	3,618
,, ,, per hour ,,	148.3
,, ,, ,, ton refuse ,,	57.2
,, ,, per hour during 2½ hours of full lighting load . . .	99
,, per hour during 2½ hours of full lighting load . . .	245

SURFACE-CONDENSING PLANTS.

THE following is an abstract of this Paper, by R. W. Allen, Assoc. M.Inst.C.E.

General questions which arise where the introduction of a condensing-plant is under consideration in connection with an existing electric generating-station are referred to; and the standardisation of condensing-plants is suggested with a view to greater uniformity in design, and in sizes of various capacities, as well as economy. Increased interest is now being evinced among engineers in the subject of the condensation of steam, owing to the introduction of the steam-turbine; and the difficulty of obtaining reliable information on the subject led the author to carry out certain experiments, whose results are given in the paper.

The paper deals with surface-condensing plants only, and two series of experimental results are given, designated as "Series A" and "Series B." The results of Series A are from a condensing-plant attached to a generating-station, consisting of three steam-driven generator sets of 365 kilowatts total capacity, the generators being chosen as nearly as possible to run at their respective full loads, as the demand varied; those of Series B are from a specially designed experimental plant capable of dealing with 3,000 lbs. of steam per hour, constructed and run under conditions approximating very closely to those pertaining to surface condensers directly connected with steam-turbines.

A brief description of the construction of the surface condensers is given, and also the results of experiments made for determining the frictional loss of head in condenser tubes in relation to the flow of circulating water through them. The use of reciprocating and centrifugal pumps for the circulating water is dealt with. As a check on the satisfactory working of the plant, the author adopted the practice of calculating what he terms the "vacuum-efficiency," namely, the ratio of the actual vacuum obtained to that theoretically possible in a space filled with water-vapour only, at the temperature of the condenser. The trials of Series A are then fully described. The amount of steam dealt with by this condenser varied between from 4,500 lbs. and 7,000 lbs. per hour. All circulating and condensation water, and all fuel used, was carefully measured. Two tables of data are given, one referring to one generator-set only at work with a load-factor ranging from 88 per cent. to 95 per cent.; the other to two generator sets at work with a combined load-factor ranging from 72 per cent. to 75 per cent. The range of vacua used was from 5 in. to 25 in. of mercury.

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Electrical artisans should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles on subjects of importance to themselves.

Armature Tests in Repair Shops.

By ARTHUR B. WEEKS.



NOT every armature winder has a room in which to carry on his work ; should this be the case, strike off a partition somewhere, running a trolley tap into the improvised room, as shown in the accompanying sketch. The wire should be run through a porcelain tube where it passes through the partition wall, and be anchored to an insulator at the further side of the room. Next fasten a fuse block to the wall, making up a wooden support for this and for the switch and rheostat, should the side of the building be of corrugated iron. Should there be no rheostat to spare, rig up a tank or barrel for this purpose, locating it in a pit below the floor line, should there be such a pit available.

Place the armature to be tested on a support as shown, and on a near-by table a direct-current ammeter of 0 to 150 amperes capacity, and a voltmeter of 0 to 600 volts on one scale, and 0 to 10 on the other. Make connections as shown. A support is necessary for the brush-holder yoke, so that it may occupy the same relative position as in the motor. This is shown in Figs. 1 and 2. Fasten it to the " horse " with wood screws. Use the holes in the brush-holder yoke for its support. Allow clearance between the armature shaft and the support, if made of iron ; otherwise the readings will be misleading.

Before testing it is necessary to say more about the voltmeter. A regular meter reading 0 to 550 or 600 is entirely satisfactory for some tests, but is not sensitive enough between 0 and 5 for testing bar to bar on the commutator, one from 0 to 10 on a second

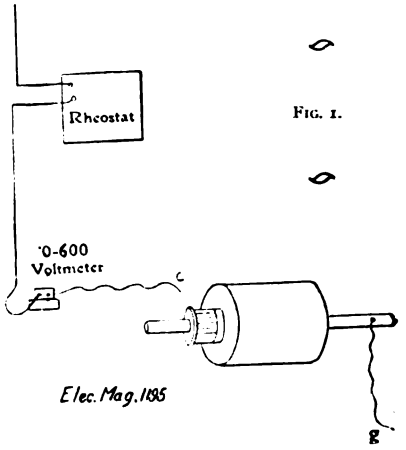


FIG. 1.

scale being best adapted for this purpose. There are three binding posts, one for a common connection, one for the 600 scale, and the other for 10 scale. Do not make a mistake in the binding posts when testing.

Everything being ready, with brushes ground to a good fit, close the switch and turn on the rheostat until a current of about 40 to 50 amperes passes ; the rheostat will stand this for some time. Now, suppose the armature has been completely rewound, and one desires to know if there are any cross connections, or if short-circuits exist in the commutator or coils. With the voltmeter

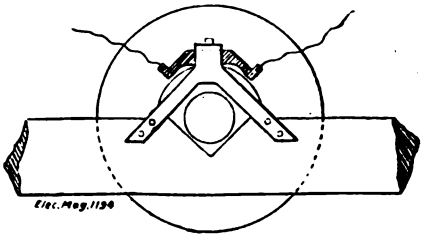


FIG. 2.

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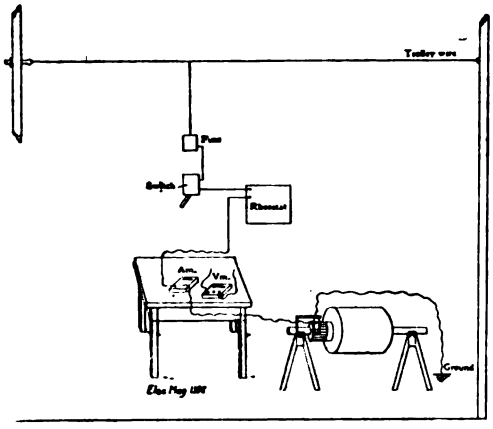


FIG. 3.

connected for the low-reading scale, make contact, bar to bar, pushing the armature over a little at a time, to reach each of the bars in turn. Begin on either side, as most convenient. If everything is normal, the reading will be anywhere from 1 to 4 volts, depending upon the character of the winding and the points where the voltmeter is applied to the commutator. If the voltmeter shows zero, there is a short-circuit. This is usually caused by solder having run down the back of the commutator when soldering in the leads, and by this test it may be located and removed in a few moments. Use a scratch awl for removing the solder.

To test for a grounded armature, which should perhaps be the first test made, since the above test made on a grounded armature might seriously injure the insulation, the ammeter is not required at all. Disconnect the lower wire from the rheostat and armature, and take out the brushes, connect as in Fig. 3, and touch the commutator with the free end, *C*. Whatever reading there is shows leakage. Touch the free end, *C*, on the armature shaft and the full line voltage is obtained.

If a ground exists, disconnect the leads of the coils from the commutator bars affected, and further probing may trace the trouble to a coil grounded on the core in its slot, or it may be the commutator is grounded. If the grounded armature has been just taken out of service, the chances are that the commutator will show by discolouration the part affected.

Before testing from bar to bar for any fault, it is a good plan to sandpaper the entire commutator thoroughly. On any railway motor commutator that has been used at all, one can get a ring with a magneto from bar to bar all around it after it has been entirely disconnected, or if five lamps in series are used for testing they will light up. In most cases this is caused by carbon dust, though in some cases it has been traced to a too free use of fluid acid flux. The writer recalls a case where a commutator of a 500-h.p. machine had its mica insulation ruined by the too lavish use of fluid flux which attacked the copper to such an extent that the commutator required an entire dismantling, the bars cleaned, and new mica segments inserted. All manner of schemes were first tried for correcting the trouble, but without avail. The motor was tried with current, after having been first connected, but the commutator grounded on the inside and burned a great hole before the machine was pulled off the line.

There are easy formulas used in connection with these meter tests which can be easily worked out by any one. Take, for example, the ground test, where the voltmeter is in series with the armature. If one has never connected a meter in this way and is not familiar with testing instruments, he may have an idea that the current may burn it out. This is erroneous, as the resistance of the voltmeter is very high, about 80,000 ohms, and prevents any rush of current.

It is best to test electric apparatus when warm. If a commutator has been repaired and fresh shellac or varnish used in the segments, bake the moisture out either before or after the commutator is connected, and always test after baking. The use of the voltmeter in testing for faulty field coils gives one a sure test. It is a great saver of time and material; for without its use it is no uncommon thing to be compelled to tear out coils and dig into them one after another, before the right one is found. And often after all this expense the coils have been found all right and the trouble located elsewhere. The proper instruments should, therefore, be provided for the careful testing of apparatus in every well regulated electric light or railway plant.—*American Electrician.*

Electrical workers in large shops should consider these columns open to them at all times. We are always pleased to hear from them, and will consider contributions for this section at all times.

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WIREMEN'S SECTION.

Conducted by STUART A. CURZON.

Notes.

EMPLOYMENT is still improving. The returns sent to the Labour Department of the Board of Trade show an improvement over the last month; the figures for which were given in our last issue. The total returns sent in numbered 4,422, made up by 3,060 from masters and their federations—1,294 from the various trades unions and 68 from other sources. All the more important trades are represented in these figures, but analysis shows the most improvement in the engineering industry.

The figures for the latter show that the percentage of unemployed during February was 7 per cent. as against 8.1 per cent. for the previous month and 6.7 per cent. twelve months ago. We are still worse off than last year, but at the present rate of increase we can hope to pass last year's returns next month.

It is often a matter of considerable convenience to determine the polarity of a generator previous to joining it up to the board. Especially is this the case when making repairs and alterations to multipolar machines. To do this take an ordinary voltmeter of the permanent magnet type, and connect to the brushes. When negative is joined to positive terminal of voltmeter the indicator hand will go hard over on the stop. When joined correctly the hand will read across the scale.

The sixth edition of *Practical Electric Light Fitting* (F. C. Allsop: Whittaker and Co. 5s.) has reached us. While this book contains subject-matter that may be of considerable use to the budding electrician, yet it is somewhat surprising that, notwithstanding six editions, the crude and dangerous errors contained therein have not been climinated. The illustrations on pages 198, 199, and 201 are so radically wrong that it makes one wonder where the author gained his experience. To cover wires for some distance and then to leave them bare in such a manner as shown in the illustrations referred to is one of the things to be carefully avoided, and it is to be hoped that before a seventh edition is reached Mr. Allsop will alter this. It is not the sort of thing to put before beginners.

The joint, too, shown on page 199 is not a good one at any time.

Perhaps the author will glance through the opening to chap. xiii.

When wiring premises on the loop-in system it would be as well if more attention was paid to the actual loop. To be correct the wire should not be cut at all, but actually looped. Where this is not convenient, do not twist the wires together so tight that the rubber is split—what is usually done. Give them one turn and solder together. This will have a great effect on insulation throughout a job, as there are usually a good many loops where the twisting has brought the wires in contact with the tape.

The writer recently heard an interesting argument as to how the best joint could be made. On one hand, it was held that a good joint cannot be made on a cable with resin as a flux owing to the burning of the resin before the centre strands had been raised to a sufficiently high temperature to take solder. It was therefore maintained that the American method of using spirits was the better of the two as the danger from its use was not as great as that of a bad joint.

There is much in this, provided that the joint is carefully cleansed with dilute ammonia after the use of spirits. One method that was omitted in the discussion was the use of the metal-pot. By this means good joints can be made without any fear of burnt resin.

However, it must be remembered that English rules demand the use of resin, while American rules are just as arbitrary on the use of spirits.

There have been a series of articles appearing in the *English Mechanic* by Mr. G. H. Alexander, M.B., A.I.E.E., in which the author sets out to instruct the budding electrician in "the Elementary Principles of Electrical Engineering." That mistakes are made and faults occur in installation work is scarcely to be wondered at if such instruction is the basis of electrical knowledge acquired by the coming wireman. So many errors occur in the articles referred to that it is difficult to particularise, but to give the most glaring instance will perhaps suffice.

To quote Mr. Alexander when explaining the carrying capacity of wires. He says: "Suppose it is a No. 17 (why a size so rarely used?) we find at a current density of 1,000 amperes to the square inch this wire will safely carry 2.46 amperes at 100 volts, *or double this amount at half the voltage;* or again, if we take a cable containing nineteen strands and one of the wires

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being gauged it turns out to be No. 16, by table we find 19/16 conductor carries 61.2 amperes at 100 volts, *or 30.6 amperes at 200 volts.*" (As a matter of fact, a 19/16 carries 62.4 amperes.)

Now, surely this is bad enough when the writer poses as an instructor to the uninformed.

It so happened, however, that an intelligent reader could not follow Mr. Alexander, and asked for further explanation. The reply is truly wonderful. It reads: "At a current density of 1,000 amperes per square inch No. 17 wire carries 2.46 amperes × 100 volts = 246 watts. This conductor will safely carry *double this amount at half the voltage, i.e.*, 4.92 amperes × 50 volts = 246 watts, as it conveys the same power or number of watts as before. Again, it will convey half the current at double the voltage *i.e.*, 1.23 amperes × 200 volts = 246 watts—the same power as before." Truly wonderful.

Then right on top of this he tells the aspiring electrician that in this latter case the current density is only 500 *amperes per square inch.* Did it not occur to Mr. Alexander that if halving the amperage halves the density, to double one must double the other?

Would a 17-G wire carry 123 amperes at 2 volts? And what have volts and watts to do with the carrying capacity of a wire or cable?

There has been some discussion in the columns of the *American Electrician* on the question of storage battery charging. As usual, the point of taking a voltmeter reading to show when fully charged is the subject, and as such seems to be a general method it would be as well if those in charge of accumulators were more chary of taking these readings as any criterion. There are even two methods of doing this—one with current flowing and the other when disconnected. Either is bad and should not be relied on at all. The usual top reading of 2.5 volts per cell may be good enough for a new battery or one in thoroughly good condition. But there it is not much guide as a rapid fall occurs in the voltage immediately after charging. The reading on the voltmeter will greatly depend on the condition of the plates as to sulphate and also as to whether it has been overcharged or discharged. No test that can be made equals that of acid density, and the use of an hydrometer both before and after charging is the one which battery attendants should rely upon solely. Experience will also bring a knowledge of plate colour whereby a full charge can be roughly determined.

Two minor points in this connection should not be overlooked. The water used to dilute acid should be soft. If this is not available boil hard water before using it. Be sure that acid is quite cold when using hydrometer.

Will all those foremen wiremen who may read this and whom we are not already in communication with kindly send their names and addresses to this office when propositions greatly to their advantage will be laid before them.

Numerous replies to the lamp solution published last month have been received and will be dealt with in next issue.

Testing.

Is there anything in connection with electrical installations which is more unreliable or misleading than the insulation test taken by supply companies and local authorities upon completion of work. The same old formula is gone through religiously. A man—sometimes two—will arrive on the job with an ohmmeter and generator. The mains are connected together and a convenient water-pipe is used as an earth. A few turns of the handle, a reading of, perhaps, four megohms, and the work is passed.

The next thing to arrive is a fire—and another dozen "doubtfuls" decide on the most faulty of all illuminants: gas.

It is the wireman who suffers most in consequence. Dozens of people are kept from adopting the modern light because of incidents of various kinds which occur to installations that have been put in for their friends or acquaintances at cutting rates. At the same time others greedily snatch at the low price quoted by some little firm employing men who are quite incapable of putting in good work.

Electric light is admittedly the best and safest illuminant extant—provided proper materials are used and competent men engaged, and it is the duty of the supply authorities to further these conditions as much as possible. Instead of wiremen being out of work, they should be difficult to secure, as every business man is alive to his own interest where safety and utility are concerned. Careful inspection of installations, both as to materials and workmanship, would be a factor in securing more consumers for the supply and more work at better wages for the journeyman.

There is a very far-reaching side to this question. Take the shopkeeper in an ordinary suburb where perhaps the lighting is in the hands of the local authority. Jones—the cheesemonger—has decided upon the adoption of electric light. He knows—as a

* The italics are ours.

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man with some interest in local affairs—that a competent staff is kept by the electrical department and he is informed that all work is *tested* before being connected to the mains. He relies on that—not on the contractor who is wiring his place. He doesn't ask the wiremen how much an hour they get, nor can he judge whether they are competent to instal his supply in the way it should be done. His faith is entirely in the staff at headquarters. He probably rubs his hands and smiles when the assistant says, "You will have your light on in an hour." And so the jerry contractor creeps on successfully—cutting wages to the lowest possible—using materials of the worst quality—and losing numbers of customers who would have brought work of the proper kind to the hands of the genuine electrician.

Many of the men who read this will doubtless call to mind cases where the fuses on a doubtful circuit have been cut previous to the test being made and it all goes through.

This policy of shirk hits the journeyman hard. There is no incentive for him to produce good work and his wages are kept down by the competition of men who could not turn out a decent job to save their lives. Surely there is as much need for the proper inspection of electrical work as there is in the case of drainage. Yet with the latter careful inspection is made, besides tests.

The decent hand—whether electrician or wiremen—has no fear of his work being examined, and would welcome closer observation on the part of outdoor superintendents as it would give him a chance to fight against the plumber-gasfitter-electrician of doubtful capabilities.

It is a common thing to find fuses in a distribution-board, controlling perhaps six or seven lights, which are big enough for the main. It is fuse-wire and that is good enough. Wiremen want to remember that the main fuse is merely to protect the mains, and local fuses should be gauged to blow at from 50 per cent. to 100 per cent. overload—the bigger the load the less the margin. The use of single-pole branch fuses is also to be condemned.

Badly made joints are another source of trouble, and one which will cause overheating. There is also the wrapping of the joints. It is necessary to bear in mind that the best joint is not perfect and a little extra trouble with the insulation will not be wasted.

We are anxious to hear from all wiremen interested both in this section and also in the Magazine.

You need only send a post-card, marked Wiremen's Section, with your name and address. Nothing more.

How to Wire a Fire-Station.

INSTALLATIONS of electric light are a general thing in fire-stations, and a simple method of satisfactorily wiring them will probably be of use to those engaged in such work. The essential point to be observed is that immediately the alarm is given every light in the station must be immediately switched on without putting out any lights previously in use. With the system described here the extra cost is not great, and it has the advantage of simplicity. As the circuits will be split up, use, say, one-sixteens for switch wire and three-twentys for the other, thus avoiding confusion. To show how easy it is to fall into error over this, quite recently a Midland town invited tenders together with schemes for lighting on the lines indicated. In every

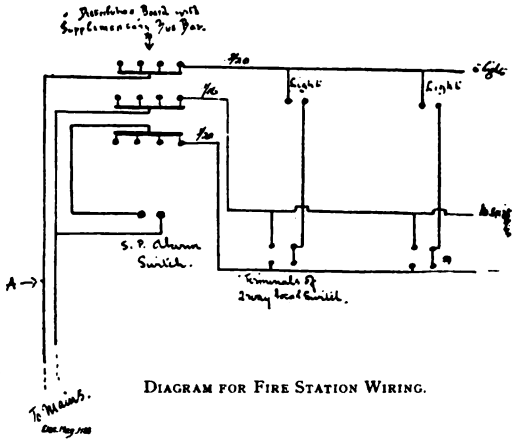


DIAGRAM FOR FIRE STATION WIRING.

instance the local contractors were at fault. Most of the methods described by them were so devised that on any one switch being put on the whole of the lamps would be lighted. The reason for this seemed to be the failure to remember that all the switch-wires from the lights to the emergency switch must meet somewhere.

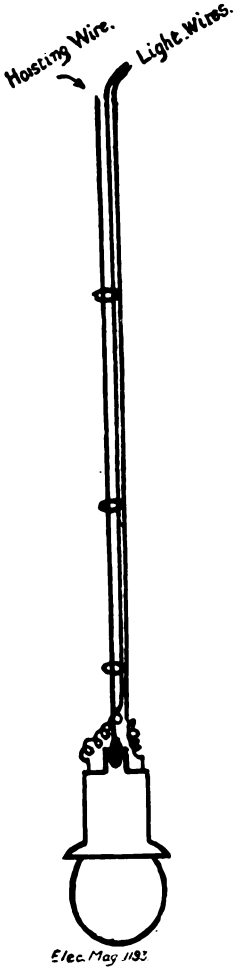
Every local switch should be of the ordinary two-way pattern. Take the light wire to the barred side of the switch. One feed from the distribution-board should be taken to one terminal of switch and a feed from the supplementary bus-bar fuses to the other switch terminals. This latter should be made the bottom terminal in tumbler pattern switches and the usual "off" position in others. The main feeding the switch side bus-bar should be tapped at a convenient place and a wire run into a single pole-switch and from there to the supplementary bus-bar. This switch must be fixed in a prominent position—say, by the annunciator-board—and must be big enough to carry the whole load.

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This arrangement can be extended by using an automatic switch actuated by the ringing of the alarm. Great care must be taken, however, that the method adopted works well, as automatic devices actuated by light currents are not always to be relied on. An easy method is to use a relay from the alarm. Take coils and armature as for a large bell. A forked plunger can be fitted to this working in mercury pots. Or an automatic cut-in switch can be used in a similar way. At the same time an ordinary single pole-switch is the most reliable.

Many other uses for this system of wiring can be found and most installation foremen will find it useful at some time.

To give a few instances where it may be used to advantage, take hospitals and such buildings. Then factories and workshops. In this latter case some lights are nearly always in use, but it is not always convenient to have the same particular lamps alight and therefore pilot circuits are not satisfactory. Neither is it wise to leave the control of the lights to individual men. With this arrangement the whole of the lights are under control from one position. It is necessary in this case to fix a second single-pole switch at point marked A.



ARC LAMP WIRES.

THE adjoining sketch shows a cheap and satisfactory method of dealing with arc lamp wires where cable absorbers are not used and cost has to be considered. This, of course, only applies where lamps have to be alight when lowered. Take a few ordinary brass curtain-rings and tape on to lighting cable at spaces of about two feet. Pass the hoisting-wire through the rings and the wires will coil up above the lamp when hoisted. This is most useful where it is essential that the wires should be kept clear of moving objects such as in 'bus-yards, stables, &c.



Any books reviewed in this section will be forwarded on receipt of published price.

"The Imperial Directory of Electric Lighting and Traction, 1905."

Edited by C. VESEY BROWN. London: Hazell, Watson and Viney, 52, Long Acre, W.C. 12*s.* 6*d.*

This valuable Directory is now in its fifth edition, and is a considerable improvement on its predecessors. It has been considerably enlarged, and a colonial section added which cannot fail to meet with appreciation. The Canadian Section will be found very interesting, and a brief glance over its references to plants operating there will convey more in a few minutes than weeks of searching through Canadian or American papers.

"The Electrical Engineer's Central Station Directory, 1905."

London: Biggs and Co., Salisbury Court, Fleet Street, E.C. Price 3*s.* 6*d.*

Central station men would be lost without this annual record of their stations, their doings and themselves. In addition to containing concise particulars of all the central stations in the United Kingdom, it gives many valuable tables showing the financial returns of these undertakings, and in this respect affords exceptional opportunities of comparison between frequently competing stations. The section on tramways has been considerably enlarged and brought up to date, as has also that relating to electric railways. There is much other information constantly needed by central station men which has been carefully arranged. The colonial section is extremely valuable for reference, as is also that dealing with isolated plants.

"'The Electrician' Electrical Trades Directory and Handbook, 1905."

The Big Blue Book. London: "The Electrician" Printing and Publishing Co., Ltd., Salisbury Court, Fleet Street, E.C. Price 15*s.*

We have before us the twenty-third annual edition of this mine of electrical information, and must say of it that it is as indispensable as its predecessors. Its regular production must be a task of no mean proportions, and the publishers are to be complimented on their enterprise in bringing the 1905 edition out to time, despite the very extensive alterations and additions which have been necessary. Among the latter we may

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mention the special rules of the Home Office in regard to the use of electricity in coal mines, and the agreement between the Postmaster-General and the National Telephone Co. relating to the purchase of the latter's undertaking in 1911, both of these being issued late in February. A veritable compendium of electrical information precedes the Directory matter proper, covering the most recent developments in every branch of the industry. Among this we may specially mention a complete record of wireless telegraphy progress during 1904. The legal aspect of the industry is fully treated, and in addition there is a specially prepared digest of the law of electric lighting, traction, &c., by Mr. A. C. Curtis-Hayward. In every respect the Directory is a necessity to every electrical engineer engaged either in the fields of research or practice. We must not forget the admirably compiled tables, which accompany each copy, from which can be seen at a glance the fullest particulars of every supply station and system in the country, whether for power, lighting or traction.

"Cyclopedia of Applied Electricity."

Prepared by a corps of experts, electrical engineers and designers; Chicago, U.S.A. American School of Correspondence, Armour Institute of Technology. Price $30. (Can also be supplied on special terms which we will readily forward on application.)

This magnificent Cyclopedia of information on electrical theory and practice, in five substantial volumes, is a welcome addition to the already swollen ranks of technical publications. It emanates from an enterprising American Technical Institute at Chicago, being a collection of the courses of instruction in electricity issued by the American School of Correspondence, together with numerous original articles from the best of America's electrical men. We can strongly recommend this work to the notice of our student readers, to wiremen and to those engineers who have a limited knowledge of electrical theory and practice. It is not possible to review the volumes in their entirety, as they contain so much detailed matter, but we can give our readers a *résumé* of their contents which will be sufficiently indicative of their character and quality. The Cyclopedia is divided into five parts. The first deals with the elements of electricity, the electric current, measurements and the telegraph. Part II. is specific in its treatment of dynamos, motors and storage batteries; and Part III. goes fully into the questions of electric lighting, electric railways and power stations. Part IV. expounds the theory of alternating currents, and deals also with power transmission; and Part V. contains a comprehensive exposition on telephony, including also a complete index.

The practical value of the separate treatises is greatly enhanced by the style adopted, this being fully explanatory of the smallest details, while the many illustrations of standard types of apparatus with which each part is embellished fixes in the mind the object constantly aimed at in the text, namely the inculcation of a theoretical knowledge of electrical apparatus which will serve a practical purpose in the operating field. Another feature—an enticing feature we might almost say—is the admirable review at the end of each part, in the shape of questions on the problems and apparatus dealt with. These should be of immense value to the reader in helping him to cross-examine the knowledge he acquires from each series, and thus to retain in his memory the varied information he has sought to obtain. Each volume is handsomely bound, and both text and illustrations are admirably printed; in fact, the entire edition is a credit to its compilers and publishers.

Monographien über angewandte Elektrochemie:

XIV. (Electrolytic Process for Producing Parabolic Reflectors.) By SHERARD COWPER-COLES. Translated by Dr. Emil Abel. Price M. 1.

XV. (Artificial Graphite.) By FRANCIS A. J. FITZ-GERALD. Translated by Dr. Max Huth. Price M. 3.

XVI. (Electrolytic Production of Zinc.) By DR. EMIL GUNTHER. Halle a. S.: Wilhelm Knapp. Price M. 10.

We are glad to note that the publication of this valuable collection of monographs, commenced some time ago by Messrs. W. Knapp, is being continued with vigour, and evidently the publishers' enterprise is meeting with the support which it so richly deserves.

The first two monographs on our list are translations of papers already, no doubt, well known to English readers interested in the particular subjects of which they treat.

The last monograph forms an exceptionally clear and complete account of the electrometallurgy of zinc. The interest in this subject seems to be somewhat in abeyance at the present time, and this may possibly be due to the fact that while electrolytic methods in the copper refining industry were making extraordinarily rapid strides, the attempt to apply similar methods in the case of zinc did not meet with much success, but rather with discouraging failures. The author of the monograph under review, who, for several years, was engaged in the electrolytic manufacture of zinc, does not, by any means, subscribe to the pessimistic views advanced in some quarters but holds out hopes for the future.

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The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects are arranged *under subject-matter* in this section. Suitable references are made to the names and dates of the various papers, and the whole forms an index guide of considerable importance and value.

Power.

Articles.

Steam Turbine Plant of the Public Service Corporation.	*Strt. Rly. Jrnl.* 18/3/05.
Electric Equipment of Hotel Astor, N.Y. W. E. Crane.	*Elec. Wrld. & Engr.* 11/2/05.
Gas and Electric Plant at Muskogee.	*Elec. Rev. N.Y.* 11/2/05.
*Power Plant of Chattanooga Electric Co.	*Elec. Rev. N.Y.* 25/2/05.
20,000-volt Continuous Current Group for Vienna Polytechnic. E. Guarini.	*West. Electn.* 11/2/05.
Edison Electric Company's System in Southern California.	*Elec. Wrld. & Engr.* 25/2/05.
Comparative Voltages-Grounded Transmission Mediums. J. S. Richmond.	*Elec. Wrld. & Engr.* 25/2/05.
*Electrical Equipment of Harland and Wolff's Shipbuilding Works.	*Electn.* 10/3/05.
Gas-Engine Economy. G. Miller.	*Machinery, Feb./05*
Hydro-Electric Plant of North Mountain Power Co.	*Jrnl. Elec., Power, & Gas, Feb./05.*
Modern Overhead Electric Lines for the Transmission of Energy. A. L.	*L'Ind. Elec.* 10/2/05.
Continuous and Alternate Current. Cusmano.	*L'Ind. Elec.* 10/2/05.
Steam Turbines. Drin.	*La Rev. Elec.* 15/2/05.
Steam Turbines: Their Application, from an Electrical Standpoint. Munch.	*L'Eclair Elec.* 18, 25/2/05.
The Wear in Turbines. Dalemont.	*L'Eclair Elec.* 25/2/05.
Electric Installation in a Wool-Spinning and Weaving Factory at Albino. Steens.	*L'Eclair Elec.* 25/2/05.
Steam Turbines. Different Applications. Drin.	*La Rev. Elec.* 28/2/05.

Papers.

Effect of Load Factor on Cost of Power. E. M. Archibald.	*Canadian Soc. Civ. Eng.*
Economics of Transmission Problems. F. A. Perrine.	*Brooklyn Poly.* 9/2/05.
Wave Distortion on Transmission Lines. W. S. Franklin.	*New York Elec. Soc.* 18/1/05.
*Power Gas. F. H. Bowman.	*Leeds I. E. E.* 16/3/05.
Internal Composition Engines. D. Clerk.	*Soc. Arts*, 17/2/05.
*Electric Lifting Machinery. E. C. R. Marks.	*Birm. Elec. Club*, 11/3/05.
*Manchester Tramways Power Supply. H. C. Gunton and S. L. Pearce.	*Manch. I.E.E.* 21/2/05.
*Application of Electricity to Industrial Purposes. J. F. C. Snell.	*North-East Coast Inst. Engr.* 24/2/05.

Traction.

Articles.

Repair Plant of Detroit United Railway.	*Strt. Rly. Jrnl.* 11/2/05.
Power Distribution of Louisville Railway Co.	*Strt. Rly. Jrnl.* 11/2/05.
*Indianapolis and Cincinnati Single-Phase Line.	*Strt. Rly. Jrnl.* 18/2/05.
Tokio Tramway Co. E. A. Baldwin.	*Strt. Rly. Jrnl.* 18/2/05.
Lansing Suburban Traction Co. J. L. Dixon.	*Strt. Rly. Jrnl.* 25/2/05.
Shifting Locomotive for Brooklyn Rapid Transit Co.	*Strt. Rly. Jrnl.* 25/2/05.
*Summer Resorts. R. T. Gunn.	*Strt. Rly. Jrnl.* 25/2/05.
New Paris Electric Railroad. H. C. Durand.	*Elec. Rev. N.Y.* 18/2/05.
Early Days of American Electric Traction. S. B. Field.	*Elec. Wrld. & Engr.* 25/2/05.
Birmingham and Midland Railways, Ltd.	*Lt. Rly. & Try. Jrnl.* 3/3/05.
The Erection of Overhead Lines.	*Lt. Try. & Rly.* 3/3/05.
Electric Trains, Schieman's System.	*La Ener. Elec.* 10, 25/2/05.
Signalling Systems on Electric Traction Lines. (Concld.) Guarini.	*Rev. de l'Elec.* 15/2/05.

Papers.

Inter-Urban Passenger Traffic. E. J. Schlesinger.	*Indiana Rly. Assoc.* 9/2/05.
Electric Railway Operations in Great City. H. R. Vreeland.	*N.Y. Elec. Soc.* 13/3/05.
*The Use of Pacific Water Powers in the Electrical Operation of Railroads. R. F. Doble.	*Pacific Rly. Club*, 21/1/05.
Single-Phase Railway System and its Possibilities. C. Renshaw.	*North-West. Elec. Soc.* 18/1/05.
*Two-Motor v. Four-Motor Equipment. N. McD. Crawford.	*A. I. E. E.* 24/2/05.
Electric Railways; the Art and the Men. F. J. Sprague.	*A. I. E. E.* 8/2/05.
Some Problems on Electric Traction. T. Rich.	*Glasg. Engr. Soc.* 2/3/05.
Waterloo and City Railway Working Results. H. Jones.	*Try. & Lt. Rly. Assoc.* 23/2/05.
Tramways Permanent Way Construction and Maintenance. J. Lord.	*Leeds I. E. E.* 16/2/05.

Lighting and Heating.

Articles.

The Use of Incandescent Lamps for Decorative and Advertising Purposes.	*Elec. Rev. N.Y.* 11/2/05.
Watch Light for Mount Hood. F. L. Merrick.	*West. Electn.* 11/2/05.
Starting Device for Mercury Vapour Lamps.	*West. Electn.* 18/2/05.
New Breguet Measuring Instruments. Brunswick.	*L'Electn.* 4/2/05.
Tantalum Incandescent Lamps from Siemens and Halske. Boistel.	*L'Ind. Elec.* 10/2/05.
Cadmium Amalgam Lamp. Bainville.	*L'Electn.* 11/2/05.
The Lighting of the New Williamsburg Bridge at New York. Dary.	*L'Electn.* 25/2/05.
Electric Ignition and Lighting Apparatus at the "Salon de l'Auto." Soulier.	*L'Ind. Elec.* 25/2/05.

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Telegraphy and Telephony.

Articles.

Automatic Telephone Exchange at Battle Creek.	*Elec. Rev. N.Y.* 11/2/05.
Developments of Telephone Talking Circuits. F. A. Caur.	*West. Electn.* 11/2/05.
The Use of Trees in Military Space Telegraphy.	*West. Electn.* 25/2/05.
Modern Line Construction. W. J. Bell.	*Sound Waves, Feb./05.*
Telephone Subscribers' Extension Circuits. H. P. Clausen.	*Sound Waves, Feb./05.*
The Automatic System and its Critics. H. S. Durant.	*Sound Waves, Feb./05.*
The Televue. J. B. Fowler.	*Sound Waves. Feb./05.*
Railway Composite Systems. G. W. Wilder.	*Sound Waves, Feb./05.*
Telephone Construction Practice. H. J. Minhinnick.	*Telephony, Feb./05.*
Factory or Machine-Made Cables. W. A. Fricke.	*Telephony, Feb./05.*
Concerning Party Line Switching. S. G. McMeen.	*Telephony, Feb./05.*
The Conversion of a Telephone Exchange from the Magneto to the Central Station System. B. S. Cohen.	*Elec. Rev.* 7/3/05. 10/3/05.

Papers.

Telephony, Telegraphy, and Patent Practice. T. D. Lockwood.	*Brooklyn Poly.* 6/2/05.
Telephony. H. L. Webb.	*Soc. of Arts,* 12/3/05.
*Setting Type by Telegraph. D. Murray.	*Inst. E.E.* 2/3/05.

Electro-Chemistry.

Articles.

A Contribution to the Study of the Yungner-Edison Accumulator. Schoop.	*L'Eclair Elec.* 11/2/05.
Some Present Problems in Technical Chemistry. H. W. Walker.	*Elec. Chem. Ind. Feb./05.*

Electro-Physics.

Articles.

The Necessity of Accurate Measurements in X-ray and High-Frequency Work. W. D. Butcher.	*Röntgen Soc.* 2/3/05.
The Structure of the Atom. J. J. Thompson.	*Royal Inst.*10/3/05.
*Electrical Properties of Radio-active Substances. J. J. Thompson.	*Royal Inst.*11/3/05.
Variation of Power with Resistance in Alternate-Current Circuits. E. P. Hollis.	*Elec. Engr.*10/3/05.
Foucault Currents and their Applications. R. V. Picou.	*L'Ind. Elec.* 10/2/05.
Variations During One Period of the Luminous Flux Emitted by a Voltaic Arc Fed by Alternate Current. Léonard.	*L'Eclair Elec.* 18, 25/2/05.
Free Escapement Electric Pendulum. Ch. Fçéry.	*L'Electn.* 25/2/05.
Electric Resistance of Cristals. Celso Arevalo y Carretero.	*La Ener. Elec.* 25/2/05.

Electro-Metallurgy.

Papers.

Recent Developments in Electric Smelting in Connection with Iron and Steel. H. W. Harwood.	*Faraday Soc.* 6/3/05.
Chloro-Electrolytic Smelting. W. M. Cobeldick.	*Elec. Chem. Ind. Feb./05.*
Resistance Furnace for Crucibles. J. A. J. Fitzgerald.	*Elec. Chem. Ind. Feb./05.*
The Present Status of Electric Furnace Working. C. F. Burgess.	*West. Soc. Engr.* 10/2/05.

Manufacturers.

Articles.

*A New Design for Slow-Speed Induction Motors. C. P. Feldmann.	*Elec. Wrld. & Engr.* 3/2/05.
Some Data of the A. E. G. Steam Turbine. F. Koester.	*Elec. Wrld. & Engr.* 3/2/05.
*Testing of Synchronous Motors in Compensating in Lagging Currents in Circuit. E. A. Regestein.	*Elec. Rev. N.Y.* 25/2/05.
*A Practical Vector Diagram for Induction Motors. H. C. Specht.	*Elec. Wrld. & Engr.* 25/2/05.
*Armature Windings of the Closed Circuit Type. W. Cramp.	*Elec. Engr.* 10/3/05.
Electric Hoist for Unloading Ships. Dary.	*L'Electn.* 11/2/05.
Gola Lightning-Arrester. Goisot.	*La Rev. Elec.* 15/2/05.

Papers.

Commutation in a Four-Pole Motor. A. Catterson-Smith.	*Birmingham I.E.E.* 5/3/05.
Notes on Heating and Sparking Limits in Variable-Speed Motors. A. H. Bate.	*Birmingham I.E.E.* 15/3/05.
Temperature Curves, and the Rating of Electrical Machinery. R. Goldschmidt.	*Inst. E. E.* 9/3/05.
*The Effect of Heat on the Electrical and Mechanical Properties of Di-Electrics. R. T. Glazebrook.	*Inst. E. E.* 9/3/03.
Low-Tension Thermal Cut-outs. Prof. Schwartz, and W. H. N. James.	*Manchester I. E. E.* 14/3/05.
*Mechanical Construction of Steam Turbines. W. J. A. London.	*Manchester I. E. E.* 28/2/05.

Students.

Articles.

Alternate-Current Laboratory Testing. G. H. Rowe.	*Jrnl. Elec. Power & Gas, Feb./05.*

Central Station Practice.

Articles.

*Fuel Ash and Gas Testing. J. S. Richmond.	*Strt. Rly. Jrnl.* 11, 18/2/05.
Central Station Work in Detroit.	*Elec. Wrld. & Engr.* 11/2/05.
Calibration of Voltmeters and Ammeters. L. A. Freudenberger.	*Elec. Wrld. & Engr.* 11/2/05.
Paralleling 5,500 Turbo-alternator.	*Elec. Wrld. & Engr.* 11/2/05.
Choice of Signs in Wattmeter Problems. L. A. Freudenberger.	*Elec. Wrld. & Engr.* 18/2/05.
*Handling Delinquent Accounts. W. H. Winslow.	*Elec. Wrld. & Egr.* 18/2/05.
*Accuracy Checks of Switchboard Instruments. C. H. Sharp.	*Elec. Rev. N.Y.* 11/2/05.
Tendencies in Central Station Design. W H. Bryan.	*Elec. Rev. N.Y.* 11/2/05.
Polyphase Meters.	*Elec. Rev. N.Y.* 10/3/05.
Parallel Running of Alternators Driven by Large Gas-Engines. E. K. Scott.	*Elec. Rev. N.Y.* 10/3/05.
*Electricity Meters. C. H. W. Gerhardi.	*Electn.* 24/2/05.

Papers.

Steam Power. F. P. Roberts.	*Ohio Rly. Assoc.* 26/1/05.
The Metering of Polyphase Currents. J. D. Niss.	*A. I. E. E.* 31/1/05.
Central Station Practice. Prof. Barstow.	*Brooklyn Poly.* 14/2/05.
*Surface Condensing Plants and the Value of the Vacuum Produced. R. W. Allen.	*Inst. C. E.* 28/2/05.

Electrical Work in the Shops.

Articles.

Electric Repairing. N. G. Mead.	*Machinery, Feb./05*

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

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New Catalogues.

POWER.

Water-Wheels.—ABNER DOBLE CO., San Francisco. A comprehensive treatise on the Doble Needle Regulating Nozzle has reached us from this company. It is profusely illustrated with a number of striking views of water-jets under varying conditions, and illustrates what can be done towards increasing the efficiency of a stream of water when supplied to water-wheels. The same company also sends us a little *brochure* on tangential water-wheels which makes instructive reading. This type of wheel is becoming a great favourite in the Western States of America (*see* Power this month), and deservedly so, judging by the remarkable results, a few of which are recorded in the publication before us.

Motors.—THE BRITISH ELECTRIC PLANT CO., Alloa. The four-pole protected machines made by this company are described in an 8-page leaflet; particulars are also given of their small dynamos. Accompanying the leaflet were several loose pages containing illustrations of larger dynamos as supplied by the firm direct coupled to steam-engines. We understand that all machines are made to metric sizes. The motors are built up to 25 h.p.

Motor Drives.—G. S. FAIRFAX AND CO., Essex Street, Strand, W.C. Booklet No. 1 describing a patent gearing for reducing motor speeds to different degrees of slow speed. The devices offered all admit of the use of high-speed motors.

LIGHTING AND HEATING.

Accessories.—PRATT AND KEITH, Electrical Engineers, Aberdeen. Some hints on electrical work has reached us from this firm. The hints are chiefly on the buying of electrical apparatus from motors to electric light fittings. The pamphlet is well illustrated and written in a way to interest the average buyer.

Steel Conduit.—THE SIMPLEX STEEL CONDUIT CO., Norfolk Street, Strand, W.C. Two useful publications have just been issued by the Simplex Co.; one is their price-list for 1905 and contains illustrations and prices of everything they manufacture for wiring purposes, the other is a treatise on conduit erection and wiring by the Company's engineer, Mr. M. L. Waterhouse. It should be in the pocket of every wireman. It is of a convenient size and can readily be carried. It contains a fine chapter on installation wiring, fittings, and accessories, types of conduits, the distribution of energy and the erection of wiring and conduit installations. In addition, there are four useful tables of conductors and conduits. The diagrams are clearly printed and can be followed without difficulty, while the style is concise and yet readily understandable.

TRACTION.

Life-Guards.—HUDSON-BOWRING, LTD., Manchester. A tastefully illustrated *brochure* on the "H.B." tramway life-guard, which is fully described and further emphasised with views of cars fitted with it. The device seems to have considerable vogue.

Cheap Steam.—ED. BENNIS AND CO., LTD., Bolton, send us their latest booklet on cheap steam, which is profusely illustrated with many installations of the Bennis stoker. There is also a quantity of valuable data on economical steam raising.

TRADE NOTICES.

Gas Producers.

W. F. MASON, LIMITED, have received an order from Messrs. Rowntrees Cocoa Works, York, for 500 h.p. Bituminous Coal Gas Plant, the Plant to consist of one generator capable of supplying gas for 500 h.p., the purifying plant to be of ample capacity to deal with the gas of 1,000 h.p. when a second generator is added. They have also received an order for "Weardale" Patent Heating Furnace and Gas Producer to be erected at the Works of the Leeds Forge Co., Ltd., the Furnace to have hearth 57 ft. long by 2 ft. 6 in. wide, and to be constructed to heat plates to an even temperature from end to end for flanging. Also orders for Gas Producers and "Weardale." Patent Heating Furnaces for Messrs. Giles and Ward Foundry Co., Ltd., Birmingham.

Liverpool Motor Show.

On stand No. 20 Messrs. John Gibbs and Son, ventilating and electrical engineers, Duke Street, Liverpool, are exhibiting their new "Peerless Blower," direct driven by their patent dust-proof motor, adaptable for blowing forges or removing dust from polishing wheels. The results produced by this machine are certainly extraordinary, and will well repay a visit to those interested. They are also exhibiting a variety of electrically driven ventilating fans, and their patent quick break safety-starting switch, a most ingenious arrangement for minimising the possibility of accident with electric motors (*see* Manufacturers Section this month).

Motor Converters.

MESSRS. BRUCE PEEBLES AND COMPANY, LIMITED, announce that they have secured the order for three 500-kw. Peebles Motor Converters, to be constructed on the Peebles Bragstad la Cour patent system. These are to be installed in Dickinson Street Station of the Manchester Corporation electric supply, and will convert 6,500 volt three-phase current to low-tension continuous current direct, without interposition of transformers.

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The
Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

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THE VALUE OF EXHIBITIONS.

At one time in the history of electricity supply, when a new station was started and a few customers were on the mains, the undertakers took an empty shop in the town or borrowed the assembly rooms, and exhibited electrical apparatus on a small scale. This "show" remained open for a week or so, during which time all and sundry flocked to gaze and wonder at the "marvels of electricity." The station engineer then closed down the exhibition, and devoted his time to reducing his oil bill or checking the amount of waste his engine-drivers used. Meantime, would-be customers, who had gone the round of the exhibits and admired the apparatus, were left with such illumination as the dazzling arc lamps had given them, or such amazement as the electric sausage machine could bewilder them. Engineer and tradesman, whose interests were mutually one, briefly united at an auspicious moment, went their respective ways, the one to his costs and the other to his merchandise. To the one the close of the exhibition was an immense relief and to the other it was a brilliant spot relieving the dimness of the dull past. As the inauguration of new undertakings became more frequent so also did the exhibitions, and in each case the same proceedings of ultra-enthusiasm followed by antipathetic feelings were witnessed. In time, however, the number of new stations gradually diminished, and ultimately whenever current was first switched on, no fuss was made beyond the banquet at the works, which had come to be an indispensable feature of such ceremonies. The inhabitants were only cognisant of any change in the town's illumination by the improved appearance of the streets and those shop windows fitted with incandescent or arc lamps.

The electrical exhibition, though thus early in the field of development, was not allowed to participate beyond the opening "flutter" in the acquisition of customers to the mains, whether for lighting or power. Its real significance as a valuable advertising medium was only recognised in a few cases in which permanent showrooms were always thrown open to the public, but the majority of supply authorities allowed the matter to drop entirely, and exhibitions fell into disuse. Prospective customers meantime were left to the mercy of a canvasser, or where the services of that tout were not commissioned, to their own devices, and only by slow degrees was a respectable load built up for the supply station. In many cases, it is true, the demand for current was encouraging, and, probably as a result of the opening exhibition, was well maintained for a time; but this state of things was quite often not the experience of the smaller stations, which sorely needed all the custom they could possibly obtain.

Keen competition, both from rival illuminants and suppliers of electricity in bulk, is now bringing home to those earlier in the field the necessity for increased publicity, and the task of attracting the public eye has been again imposed upon exhibitions. The past twelve months have witnessed extreme activity in this direction, and especially in the

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provinces among comparatively small stations. During the past few weeks two London companies have followed suit but on a much more elaborate scale. The Metropolitan Electric Supply Co. have held an exhibition in Paddington, while the County of London Electric Supply Co. had taken extensive premises in Holborn, where a spacious basement and first floor accommodated not far short of one hundred exhibitors. Full particulars of the apparatus on view at the latter place will be found elsewhere in this issue. Messrs. Edmondsons, Ltd., have also a travelling exhibition now touring certain of its areas in the provinces, and, from what we are able to gather, are making good impressions wherever they "cast anchor." In another case, a central station engineer is circularising the town in which he gives a supply, with equally encouraging results. A general survey, in fact, reveals greater zeal on the part of the undertakings authorised to supply electricity, to wake up the public in their districts to the value of electrical energy for lighting, heating and power purposes.

Of the wisdom of this course no doubt need be entertained; indeed, it is a matter for surprise that advertising in an even more blatant form has not before this been the policy of electricity suppliers. The retailer of useful and necessary commodities has not scrupled to utilise every known means of advertisement, from huge posters compelling attention, to postcard paragraphs, in praise of his wares. The difference between this particular form of trading and that practised by the retailer of electricity is merely one of degree, and one which does not exclude the latter from availing himself of certain methods of the former. The sale of electricity, though as remedial in its object as that prompting a trade in pink pills, can be conducted better with judicious advertisement than without it; and moreover, the form which its methods of publicity takes need never be open to that criticism which some advertisements richly deserve. Exhibitions, for instance, are a perfectly legitimate means of acquainting a possible buyer with the merits of an article, and on this account we specially commend them as valuable to the larger suppliers of electrical energy throughout the country. The interests at stake are sufficiently important to warrant an annual outlay on a permanent show-room, at which special lectures and displays could be given regularly to maintain public interest in the undertaking and bring in new customers. By unceasing activity in this direction facts and figures can be put before wavering tradesmen and householders, who need stimulating to use electric light or power to as great an extent as they do to buy goods or produce from a certain warehouse.

Now the ball has been set rolling we may expect something of a revolutionary character in the canvassing methods of electricity undertakings. It is high time for the chief engineer to turn from jealously guarding the .000*d*. per unit of his total costs, which is strong enough to take care of itself, to at least a study of modern advertising methods, if not to the promulgation of an active policy of publicity. His assistants should be able to look after the economical running and maintenance of the plant, while he, in his capacity as commercial manager, should act also as "sales manager" to the concern. In the exhibition he has available one of the cheapest forms of advertisement, as by co-operation with manufacturers he can conduct business with a minimum of expense. It is not, of course, his only means of publicity, as doubtless the future will show, but it is one to which he may always return when all other avenues to public favour are either congested or completely closed.

Another American Tribute.

Prof. H. S. Carhart, writing to us on receipt of the Souvenir issue, says: "It is an extremely interesting number, and I shall preserve it as a valued souvenir of the International Electrical Congress of 1904. *You deserve much credit for getting together so much interesting matter and so many beautiful pictures for a single number of your Magazine."*

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Our Telegraph Correspondence Class.

SINCE commencing this new feature in our February issue quite an encouraging number of Telegraph Students have taken advantage of our special offer of tuition on telegraph and telephone subjects. We should, however, like to see an even greater interest taken in this section. Next month we shall announce a new prize scheme in connection with the class which will be a extra inducement to aspiring telegraphists to join it. We devote considerable space in this issue to answers already received and would like students to know that when their papers are not specifically referred to their answers are right or that any necessary corrections have been covered under the general notes on the several questions.

Making History.

WHATEVER may be the fate of the Administrative County of London and District Power Bill, the evidence given on its behalf will always be remembered in electrical history as marking an epoch in power distribution affairs. We may, in fact, be said to be on the borders of a revolution in electricity supply, which threatens to ride rough-shod over all that has come to be held sacred in our present methods of furnishing electrical energy. The promoters of the Bill and the best part of the opposition have brought each their own arguments to support their respective cases, but nothing advanced by either could be taken as any indication of the ultimate result. The promoters can build their stations at £10 per kilowatt as against the £51 for the average London station. Steam turbines each of 10,000 kw. capacity are to be installed and by their aid and a load factor of something over 50 per cent. the total costs are not to exceed 0.154*d.* per unit! The very figure must make even the .45*d.* engineer start out of his chair. Evidence for the opposition brought out the sanguine statement that steam turbines were all a matter of fashion which would change ere long in favour of the internal combustion engine. Municipalities claimed great things for themselves by the time the proposed "trust" was in working order, an expert on their behalf boasting of supply at 0.7*d.* per unit in five years time. One wonders if even at so short a time hence the chief factories will be still within the borders of the County of London.

Units and Standards.

So much work has been done towards increasing the accuracy of those standards which are the embodiment of electrical units that it is perhaps difficult to understand the commercial value of further investigations in this direction. Engineering works fortunate enough to possess a well-equipped laboratory and central stations blessed with a standardising- and testing-department generally consider the Clark cell sufficiently accurate for their respective purposes. The recent discussion at the Institution on the subject of electrical units, though of undoubted value to electrical engineers generally, is of greater import to that band of scientists composed of physicists in all countries in whose hands has been placed the task of constructing standards as nearly accurate as known methods and materials will permit. In this respect the work of the National Physical Laboratory, an abstract of the Directors' Report of which we published last month, is deserving of all

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praise, and we hope that it will receive more generous support from the Government than has been hitherto accorded it. That the researches at Teddington are of immense value was fully testified to by the recognition at the recent International Electrical Congress at St. Louis of the suggestions made thereto by the British delegates. Of the speakers at the Institution meeting in question, Mr. Trotter, though not officially voicing the sentiments of the Board of Trade, appeared to us to put the matter in the right light as far as engineers were concerned. His standards for all practical purposes were the ohm coil, not a mercury column, the ampere balance not a silver voltmeter, and a multicellular voltmeter (standard) not the Clark cell. We do not, of course, question in any way the finer adjustments to which laboratory standards are subjected, but in the operating field there is no need for such delicate measurements so that ordinary instruments of precision answer the purpose.

High-Voltage Trolley Wires.

THE American Institute is not allowing the grass to grow under its feet this session, if the papers presented to it are any criterion, for the most practical subjects come up for discussion, and they are discussed too! In fact matters of extreme moment to Electrical men always seem very much to the front. Among the recent subjects dealt with was that of high-pressure line construction for alternate-current railways. Two comprehensive papers on this subject, by Messrs. G. A. Damon and T. Varney, cover an immense amount of ground, in fact almost every phase of this important problem is entered into, described, and illustrated. Our American cousins, having got to work with a commercial one-phase high-voltage railway, are now evidently determined to "get there in once" with the overhead equipment to supply similar lines. The use of one-phase currents, as our readers are well aware, obviates rotating converter plant, and in time it may do away with



ANNUAL DINNER OF MANCHESTER SECTION OF INSTITUTION OF ELECTRICAL ENGINEERS. MR. C. D. TAITE IN THE CHAIR.
Photo, Entwistle and Thorpe, Manchester.

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Photo by] **Our Stand at Holborn and Finsbury Electrical Exhibition.** *[W. S. Campbell.*

See Supplement at end of Magazine.)

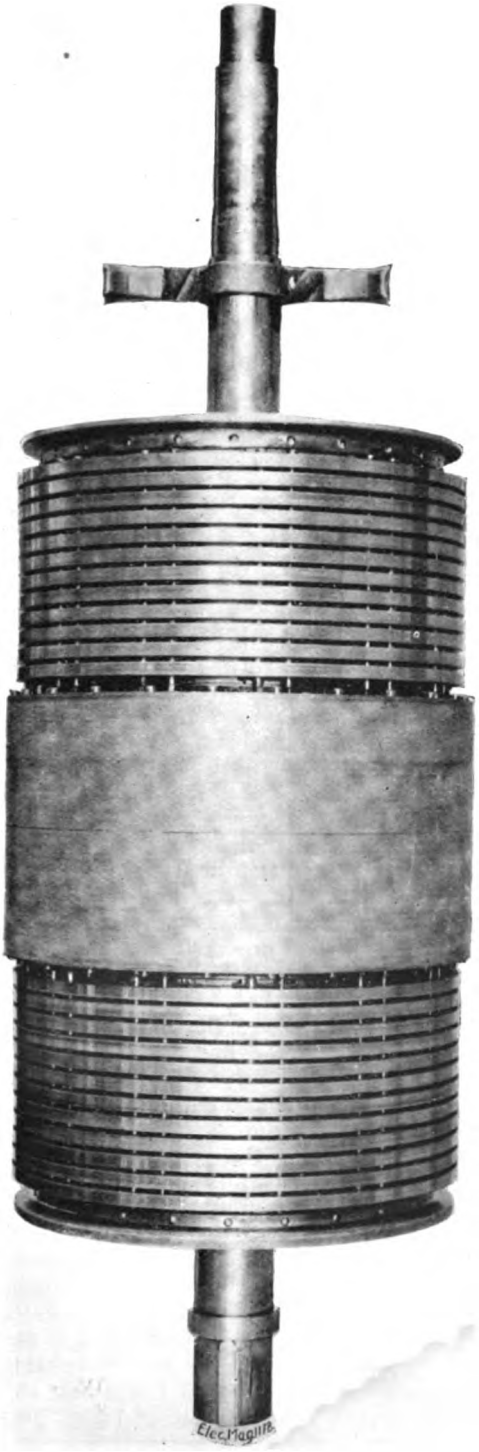
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sub-station equipments entirely. Under these circumstances the importance of suspending the feeding wire over the train, in a manner which ensures safety and efficiency needs immediate recognition. It is further obvious that improvements made in this part of the system will advance the time at which trains can be operated at what will be practically the generated voltage. On this account the papers to which we refer are very valuable and will repay careful study, as they form an accurate survey of the work done and still possible in this field. We need hardly say that the ordinary methods of supporting, insulating, and staying trolley-wires are totally unsuited for high-voltage work. As will have been gathered from the account published in our last issue of the Indianapolis and Cincinnati line, an entirely new method has been necessary, and it is with these special methods that the papers treat in detail. The catenary method of suspension, both single and double, is fully described in one of the papers, and we purpose giving an abstract of it with illustrations in our next issue. As the problem of high-voltage line construction is practically that of the electrification of main lines, it is not surprising to see suggestions from one author as to the best voltages to be adopted. For interurban service Mr. Damon considered 6,000 volts should be employed as standard to facilitate interchange of equipment, and for main lines 15,000 volts directly applied to the conductor was desirable. It was further suggested that for the former a bow collector with catenary suspended wire should be used and for the latter a contact arm similar to that described by Mr. Mordey in his series of one-phase railway articles [THE ELECTRICAL MAGAZINE, vol. i. No. 3, p. 269]. It will be remembered that this collector has been tried by the Oerlikon Co. on a Ward Leonard one-phase locomotive, and is capable of following the overhead conductor, whether it be above, below, or at the side of the contact arm.

Unipolar Dynamos.

SINCE the days of Faraday's disc dynamo the value of unipolar dynamo electric machines, though known to have a high figure, has not found practical recognition by reason of the limitations of speed of the revolving element. A generator of this type must rotate at very high speeds to give anything approaching the voltages now commonly used, and as long as reciprocating engines held the field as prime movers, direct-current generators or, as they may be called, mongrel alternators, have been built for continuous-current work. The revival of the steam-turbine has again brought up the matter of high speeds, and with it that of unipolar dynamos. Experiments on a substantial scale have been made with machines of this class by the American General Electric Co., and they are sufficiently important to rank above the category of laboratory trials. These efforts at introducing a simple type of direct-current generator formed the basis of a paper recently read before the American Institute of Electrical Engineers, by Mr. J. E. Noeggerath. Some particulars of the dynamo constructed and experimented with will be found in the Power Section this month. To obviate the difficulty of low voltage, the armature conductors are joined in series by bringing them out to rings on each side of the core, and by this means the e.m.f.s produced in the twelve conductors are added togetther. The construction of the revolving element can be gathered from the adjoining photograph. The current generated is a purely continuous one, that is, there is no reversal of e.m.f. in the conductors, consequently no commutator is required. Another interesting constructional feature is the armature core. This is of the smooth type and the conductors, which are of copper sheet and quite straight, are secured by binding wire to the surface of the core. The field system comprises two co-axial field coils, so arranged in the steel case that the flux passes into the armature at the ends outside the collector rings and emerges between the latter. The main losses are due to reaction in the rings, and the straight conductors connecting the brushes, these being surrounded by solid steel in which they give rise to varying magnetic fluxes. These latter give rise to hysteresis and eddy-currents in the steel and weaken the main field. This difficulty has been overcome by making the connections

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ARMATURE OF UNIPOLAR DYNAMO.

between the armature conductors and rings follow a spiral of one complete turn while the position of the brushes follows a spiral of one or more turns in the opposite direction. The full-load losses in the 300-kw. machine built were found to be 28 kw. exclusive of windage and bearing friction and the efficiency at 50 per cent. overload was given as 91 per cent. The machine has about the same total weight as those of the present standard type, and we should certainly hear more about it before long, judging by the valuable discussion elicited by the paper above mentioned.

President Lincoln and the Telegraph.

THE stories told by subordinate officials of the great men under whom they served will generally bear repetition, but especially so when these same officials come to be veterans in their particular cause relate their experiences. During the American Civil War the Federal armies were constantly in touch with the capital by telegraph, the receiving station being in the office of the War Department at the White House. Here the portentous cipher messages were presided over by three operators—"the sacred three"—who took duty in three shifts of eight hours in the twenty-four. These three men since risen to the top of the telegraph business in New York, are still living, and have recently given the *Telegraph Age* some account of their Washington operating experiences, but more especially their association with President Lincoln. The state secrets entrusted to the then young fellows, have now, of course, lost their significance consequently they can be safely made public. Lincoln, it appears was a constant visitor to the telegraph room, and always anxiously awaited news from the front, but he was given to beguiling the spare moments between messages with humorous stories and frequently chaff. From the great physical and mental strain constantly imposed on him he used to find relief in the narration of apparently the most trivial stories. His humour in fact got him out of many trying situations. He was once asked for a pass through the Federal lines to Rich-

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mond, and he tempered his refusal by remarking, "I should be happy to oblige you if my passes were respected, but within the last two years, I have given passes to Richmond to a quarter of a million men, and not one has got there yet." In spite of this lighter vein of his nature, he showed a genuine sympathy for soldiers in the field, and no man was ever executed for sleeping at his post if Lincoln could prevent it. He would bring messages of reprieve in person, and on no account would they be entrusted to an orderly or other messenger when human life depended on his direct action. Lincoln freely discussed the military situations with the operators, consulting the maps in the department, and making sketches of the different positions. Even on these occasions his humour came on top. When Grierson entered the confederate lines at Memphis and was not heard of for three weeks, when he arrived safely with his command at Baton Rouge, Lincoln remarked that the incident reminded him of the man who had run a needle in his hand and was oblivious of its presence until it came out of his foot fifteen years later! The three telegraph operators were David Homer Bates, Charles A. Tinker and Albert B. Chandler, the first two since retired, but the last-named still actively engaged as Chairman of the Postal Telegraph Cable Company.

Dangers of House Services.

In an action recently taken against the Manchester Corporation, by A. H. Midwood and Co., for recovery of damage by fire to stock-in-trade through the ignition of the service cables, the plaintiffs not only won their case but succeeded in obtaining confirmation of their allegation that the cable system of the corporation constituted a nuisance. Now as our readers are well aware, Manchester has always been famous for its column of smoke methods of localising faults in cables, though opinions hitherto differed as to the expediency of this recourse or its influence upon the nerves of the consumer. After the finding of this case, however, there would seem to be little room left for doubt as to the extreme barbarity of a method in which some thousands of horse-power are turned into a fault with the object of shifting it somehow. It is the custom in Manchester to lay the service cables which are rubber covered in wood or iron troughing and fill the whole in "solid" with bitumen, the cables if of large size entering the building through a "pot" insulator. Should trouble of any kind cause the rubber insulation and subsequently the bitumen to melt and give off gas, a spark, which would certainly accompany short circuit with thousands of horse-power behind it, would ignite the combustible material surrounding the cables and a conflagration would immediately ensue. The fire would be fed by the bitumen and insulation back up the troughing and unless current were speedily cut off a wholesale destruction of the length of cable would follow. It must be clearly understood that this horrific climax is only possible when a fault is speedily developed into a destructive arc with current persistently applied to it. Further, a fire would only follow when the solid system, with its troughing and inflammable contents, is actually brought into the building itself. An armoured cable laid directly in the ground even if continually backed by a large amount of power, would do nothing worse than burn itself up, but without any great danger to its surroundings.

Not the least extraordinary part in the recent legal proceedings was that "acted" by several experts summoned to give evidence on behalf of the Corporation, doubtless at considerable expense to that body. It seems incredible that engineers could be found to lend their support to so crude an expedient for removing and locating a fault as that adopted. Again it was averred that the system employed was the best known for localising a fault. Statements like this prompt the belief that some of the witnesses regarded such a method of burning out as a huge joke.

The Manchester network extends over so wide an area that experimenting of any kind is hardly possible and the mains staff can in no way be held responsible for the outcome of methods which are evidently forced upon them by the existing network both as regards its laying and arrangement. Still it cannot be let pass that such system is the best which present practice suggests.

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Readers of this journal who carefully perused the series of articles by Mr. J. Cleary, which we published recently, will be familiar with the system he described for both localising and isolating faults by the use of fuses on the distributing network. With a properly designed box to contain such fuses and a judicious placing of them on the network, the whole system can be laid out in lengths coupled only through fuses which in case of fault will blow and isolate only a short section of main. Such a system has stood the test of experience and is reliable and efficient, the evidence of witnesses in the recent case notwithstanding. Systems not provided with such precautionary devices and which stick to the "smoke" method would do better to abandon the latter in favour of less drastic remedies which are easily available despite expert opinion to the contary. A few pounds in satisfactory and reliable modifications would be better spent than hundreds in compensation, let alone heavy fees for valueless and misleading statements which bring the industry into disrepute.

THE WINDMILL.

Operated by "DON QUIXOTE."

III. Lights o' London.

THERE has lately been much fluttering of the dovecotes—if an electrical engineer can, in any sense, be compared to a dove—by the Napoleonic scheming of a group of gentlemen who call themselves the Promoters of the Administrative County of London and District Electric Power Company. The very name of the concern is too big a mouthful to be taken at one gulp, and on the principle that it takes many swallows to make a summer, we must forgive the Camperdown Committee if it continues to digest the provisions of the Bill for a month or so to come. The provisions really need some digesting. In the meantime, the powerful eloquence with which the cause of the poor power-consumer is being pleaded by eminent counsel discharging at the rate of about a pound a word is only to be equalled in impressiveness by the almost feverish zeal for good works evinced by the existing undertakings, who are now almost prepared to give electricity away with the usual pound of tea. These phenomena would be enough to stagger humanity if humanity was not hanging on to itself with both hands in order to perserve itself for the millennial joys of juice at point eight six five pence per unit. Oh that the sweet simplicity of childhood would once again return to me, that I might gaze upon these figures without thinking of piecrust!

Now, be it far from me to add my feeble piping to the discords that surround this subject like the dissonances of a Wagnerian overture. These things be too high for me. Yet, for the sake of those who are wondering what on earth all the fuss is about, I will relate a little parable. We all know what ham-and-eggs are, and that the primeness of the former constituent of the composition is dependent on the fatness and general good health of the pig at the moment preceding its decease. Very well: it is of pigs that we will discourse.

There was in a certain farmyard of restricted area an owner of a grasping disposition. And knowing that pigs were profitable he took counsel with his friends as to what he should buy. And some said he should get a great fat pig, who would swill and swell till it was the wonder of the country side. Others opposed this view, asserting that a larger number of tiny-winey little piggy-wiggies — to quote a Parliamentary phrase—each consuming a less quantity of swill, yet giving the same overall efficiency in ham, would pay better and divide the risks. It was pointed out that should the big pig become love-lorn or develop appendicitis the capital sunk would be disastrously lost. Acting on these considerations the farmer rejected the whole-hog idea and became a little-pigger. But in the lapse of time these little piggy-wiggies grew, and started to hustle one another, forasmuch as two pigs would go for one trough, and there would be severe competition in certain areas. Owing to mutual jealousies and constitutional weakness some of these pigs turned out failures in life, and the farmer stuck his hands in his pockets and brooded over the problem. And just lately he has conceived the idea of buying a nice motherly old sow who will take charge of the lot, suckle them,

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make them feel at home, wallop them for their good, and mould them into a happy little family. The obstreperous little pigs are kicking up a fearful row because they don't want to be mothered, and assert that the old sow would gobble up all the swill meant for them. And the farmer is still smoking his pipe over it. What would you advise ?

One aspect of the question has, I think, been overlooked in the general hurly-burly. What is to become of all the engineers who are at present shifting as well as they can in small independent power stations if these are replaced by sub-stations driven from a mammoth power house ? They *may* get a good living as sub-station charge-hands, but as a Scotch engineer of my acquaintance says, "A hae ma doots." This friend of mine came to me in a fright the other day. "A hev had a veesion!" he said, "A veesion o' the nicht. Hey mon, lat me bide a wee till A wipe ma broo!" I sympathised with him as he mopped. "A wes on shift the ither nicht," continued he, "and A injudeeciously lat ma eye wander alang the reporrt of the Lorrds Committee. A wesna readin', ye ken, for-bye that wad be agen the interests o' ma employers. A wes merely g'encin' it doon." I assured him that I perfectly appreciated the difference. "Mon!" he said in awe-stricken tones, "A went hame, an' that verra nicht A had the veesion! A dreamt that A had been deid for twal' years, an' I kem back an' veesited the airth. Sae I kem tae see hoo the wurruks wes daen', an' fegs, there wes nae wurruks there! A speired a mon as tae whau A cude fin' the Pooer Hoose, an' he tould me it wes up in Derrbyshire. Aweel, A traivelled tae the Pooer House, an' sure's deith it wes plented richt atop a pit-mooth! An' A walkit roond the place, an' A lookit here, an' lookit there, an' deil a body cude A see annywhere. Sae A steps intae the engine-rume, an'—losh, mon, A wes fair scunnered,—there wesna' anny smell o' warrm oil; there wesna anny engine, but a few loompish turrbines; there wesna that looscious boomp o' slack big-ends that you an' me ken sae weel. There wes only an eldricht moan frae the machines that sent a sheever doon ma spine. An' there wesna a soul aboot savin' a gentleman in evenin' dress wha slommocked aboot the spacious hall wi' his hands in his pockets.

"'Gude morn tae ye,' A says, 'Are ye the manager?' 'Well,' he says,'A'm the resident, the sheefty mon, the driver, the gas expert, colliery manager, an' fitter, aw thegether.' 'Losh!' says A, 'ye don't say sae.' 'Yes, indeed,' says he, 'an' in ma spare meenuts A mak oop the wurruks cost sheets.' An' he tould me his company had reduced the staff to 0.00000027 engineer per unit generated on the peak. An' he showed me the station. Mon, it was juist terrible! They had automatic coal-cutters which needed nae watchin', for they wurrked mechanically alang the saft coal-seams an' rejected the rocks. They deleevered the coal intae conveyors tae fetch it tae the surrface, whaur it wes fed direct intae the gas-producers by automatic dreeblers. The gas sae generated passed tae the gas turrbines which drove the generators, each of 60,000 kilowatts capacity, at 400 revolutions per second. From them the juice was transmeeted through the air at thirrteen million volts by means of Merzian waves."

"Pardon me," I interpolated gently, "You mean Hertzian waves."

"Na, na!" he replied testily, "Dinna deave me! Merz was the name. They supplied in bulk tae sub-stations at Birrmingham, Leverrpool, an' twa in London—ane for the indoostrial an tither for the non-indoostrial areas. At each Pooer-Hoose—for they had anither at Cairrdiff—they had several coal-mines that they cud run up an' pairallel at twa meenuts' notice.

"'An' whet,' A said tae the engineer, 'hes become of the men A used to look up tae an' reverence,—the Burgh Engineers?' 'Oh, *them*,' said he, 'we hae turruned them intae sweetchboard attendants at the sub-stations.' An' wi' thet A wes sae disgusted," concluded my friend, "that in ma veesion A spread ma wings an' returrned tae Pairadise whaur A kem frae!"

"And what does your vision portend?" I asked him.

"The feenish of the wurld," he replied, "For when turrbine stations are brocht tae that peetch nae engineer cud live. An' engineers arre the saut of the airth."

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Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

The Diesel Engine.

(Special Article.)

By W. H. BOOTH.



HAVING lately carried out a test on a Diesel engine of 150 b.h.p., perhaps some of the results may be of interest to the readers of THE ELECTRICAL MAGAZINE.

The engine was on the testing-bed at the works of the makers, Messrs. Carels Freres, of Ghent, Belgium. The pressure is about 35 atmospheres. The peculiarity which distinguishes the Diesel from other internal combustion engines lies in the fact that the combustible mixture is not subjected to compression. The engine draws in a charge of pure air, and this is compressed to about 35 atmospheres. The compression is effected rapidly, for the engine makes 160 revolutions per minute, and therefore the compression stroke only occupies about one-fifth of a second—actually $\frac{1}{5.33}$ and it must therefore be nearly adiabatic. Adiabatic compression of air, which is a perfect gas or nearly so produces heat and the temperature attained is high.

Taking Rankine's figures of 53.15 per pound of air, and the ratio 1.408 of the specific heat at constant pressure and constant temperature, the foot pounds of energy in compressing to 35 atmospheres if worked out by the following formula are :

$$53.15 \frac{T}{\gamma - 1}\left\{\left(\frac{p_1}{p_0}\right)^{\frac{\gamma - 1}{\gamma}} - 1\right\}$$ where

T is the absolute temperature and p_0 and p_1 the initial and final absolute pressures, and $\gamma = 1.408$.

For T = 70° F. or 530° absolute, the formula becomes

$$W = \frac{53.15 \times 530}{0.408}\left\{\left(\frac{35}{1}\right)^{0.408} - 1\right\} = 124395$$

foot pounds per pound, which, divided by the mechanical equivalent of heat is 161.14 British thermal units.

Assuming that the specific heat at constant volume is 0.169 or about the usually accepted figure would give a temperature 70° + (161.14 ÷ 0.169) = 953° F. + 70° = 1023.5° F., the final temperature being T_1. We have also

$$\frac{T_1}{T} = \left(\frac{p_1}{p_0}\right)^{\frac{\gamma - 1}{\gamma}} = 1484° \text{ absolute,}$$

or 1484 − 459 = 1025° F. a sufficiently near result to the former with approximated logarithms only. At high temperatures the co-efficient of specific heat of air, as of all gases, is probably higher than at low temperatures, and the calculated temperature is possibly not attained unless perhaps by reason of an absorption of heat, by the air from the cylinder walls during the early stage of compression; this may serve to counteract the increase of specific heat. In any case, the fact remains that the temperature is sufficient to ignite the incoming charge

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of fuel, which then burns readily in the compressed air.

To inject the fuel and spray it efficiently, a subsidiary supply of air is employed. This is compressed to about 50 atmospheres so as readily to spray the oil fuel into the main air charge in the cylinder. This subsidiary air at one time was compressed by a small pump which took its supply from the charge in the main cylinder already highly compressed, and added to it a few more atmospheres of pressure.

In the engine as now made this method has been abandoned because of the impurity of the air fed to the pump. There are now special compressing pumps, the larger of which compresses pure air to about 5 atmospheres. This air passes through a cooler, wherein it is drained of some of its developed moisture, and passes on to the second stage plunger which compresses to about fifty atmospheres, and this pure compressed air then serves as the spray blast for the oil feed. The piston velocity being considerable, and the fuel injection somewhat protracted, there is no great accession of pressure. The heat produced by the combustion expands the compressed air, and the expansion curve of the indicator diagram follows a line by so much removed from the curve of compression.

The idle horse-power of the engine is thus made up of the ordinary friction of the engine, and of the power required to drive the compression pumps. But when calculating the consumption of oil per i.h.p., it will not be proper to measure the diagram and call its area the power developed by the oil, for the following reason. The compression pump theoretically returns a very large proportion of the power it absorbs into the main cylinder. That is, it delivers air at 50 atmospheres pressure into the cylinder and raises the mean pressure therein. This power must therefore be subtracted from the diagram horse-power in every diagram at all powers. It is a constant and, unless subtracted from the i.h.p. it would make the consumption of fuel per horse-power hour exceedingly low at small powers. By subtracting the proper amount as nearly as could be determined, the figures for fuel consumption at all powers were rendered very consistent, and this serves to confirm the accuracy of the deduction. In the engine tested, the intake volume of air by the first stage pump was taken at 70° F., and the compression to 50 atmospheres, and from these data it was calculated that there would be about 12,000 calories per hour, or 47520 B.Th.V. to be subtracted from the calories equivalent of the i.h.p., that is to say, about 19 i.h.p.

The b.h.p. of the engine is, of course, easily found, as the difference between the idle and the loaded diagrams, no notice being taken of the subtraction which is equal at all powers. It is found that a b.h.p. hour can thus be produced for less than half a pound of crude oil.

The test brought up several points of interest, and enabled a comparison to be made with an engine previously tested by the writer, under somewhat better conditions. In the present test the exhaust pipe was long for its diameter. In the former case it was larger and colder, and this made a difference. At full powers the volume of hot exhaust gas discharged into the atmosphere is considerable. The weight amounts to approximately 2,400 pounds per hour and the temperature is high, about 420° C., or, say, 700° C. absolute, so that the volume is more than doubled as compared with the initial volume at about 300° C. absolute.

All this extra volume has to be delivered into the atmosphere. If the exhaust gas be assumed to be a long column of one square foot area and the length in feet be multiplied by the atmospheric pressure of about 2,116 pounds per square foot, it will readily be found that this expulsion of the hot exhaust represents a considerable duty in foot pounds. Thus, if the increase of volume is equivalent to 40,000 cubic feet, the foot pounds of work done in pushing this into the atmosphere will be $40{,}000 \times 2116 = 84{,}640{,}000$ foot pounds or $\frac{2600}{60}$ horse-power nearly, *i.e.*, about 43 h.p.

Thus, fully half of the idle horse-power of the engine is explained by this expulsion resistance at full load. At the idle load itself the exhaust temperature is much lower, and the resistance is probably only 20 h.p. to 30 h.p. This point is worth noting in all gas-engines. The exhaust gases should be turned into

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a large exhaust pipe, and well cooled if this can be conveniently done. We remove from a steam-engine the duty of pushing its exhaust steam into the atmosphere very thoroughly, because steam will condense into a liquid. The principle of condensation applies equally, but in less degree to the internal combustion engine, and it is wise and economical to reduce the volume of the exhaust by cooling it. For some time a long exhaust pipe has been recommended with the idea of getting back some of the energy of motion in the gas. But this amount of energy does not calculate to much, and it would rather appear that the benefit of the long exhaust pipe of the internal combustion engine has been due to the cooling of the exhaust, and the reduced displacement of the atmosphere that is necessary.

One would like, of course, to get more energy out of the gas by expanding it lower and reducing its temperature by performance of work. But the gain by expansion can only be got by aid of large cylinders, and the commercial economy is doubtful. Thus, the exhaust pressure at full load in the Diesel engine is 30 to 35 pounds above the atmosphere or 45 to 50 pounds absolute. Three expansions would take it down to the atmospheric pressure. An ordinary double-acting engine with a stroke volume equal to about that of one cylinder of a two-cylinder Diesel engine would expand the waste gas to atmospheric pressure from an initial pressure of three atmospheres. The mean pressure would perhaps be 15 pounds effective, and the horse-power about 60 net or say 50 b.h.p. at most, or one-third that of the main engine. Usually it would cost very much less to lay a large and cooled exhaust pipe so as to reduce the displacement volume of the exhaust gas and gain something of the waste back again. But 50 h.p. does look worth trying for, and high exhaust pressures may yet be utilised. This would, of course, involve a higher back pressure on the first pistons, and the power actually gained would be less than that generated in the second cylinder. The ordinary difficulty in compounding a gas-engine is the absence of condensing and the necessary high pressure of the exhaust from the first stage cylinder. Only by high initial pressure can such useful final pressures be secured.

In working up the results of the test, the metrical system was chiefly employed, because all thermometers, engine dimensions, and the indicators and water meter were made on a metrical notation. The oil used contained about 10,722 calories per kilogram, and in the diagram of data and results the vertical scale was laid out equal to 40 kilograms of oil per hour, or 428,888 calories. Then, on the sloping line from 0 to 40 representing oil per hour, ordinates were set up at 13, 14, 17.5, 22, 26, 28 and 32.4 kilograms, which were the rates per hour at which oil was burned on the several tests.

Obviously, therefore, the calories per hour for each test are measured by the height of the ordinate at each of these points intercepted by the sloping line AR. The calories equivalent to the meter kilograms of work shown on the

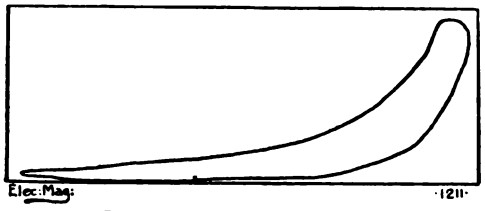


DIAGRAM FROM LEFT HAND CYLINDER.
(SCALE 1 MM. = 1 KILO PER CM².)

indicator diagrams are plotted on each ordinate and joined up to form a broken line. The irregularity of this line simply represents errors of observation and diagram measurement, and the "curve" is very properly made fair and even by drawing a straight line or Willan's curve through the field of the plottings. From this line are then plotted the calories found by multiplying the reading of the water meter by the rise in temperature of the jacket water.

This curve is also made fair, and a parallel to it is drawn below it a distance of 12,000 calories to represent the proportion of jacket heat due to the air pump. The same was done, of course, with the curve of calories in the i.h.p. before laying off the water calories. Finally the calories in the exhaust gases were plotted off above the water-line as a basis. It is very usually granted now that the specific heat of all gases increases

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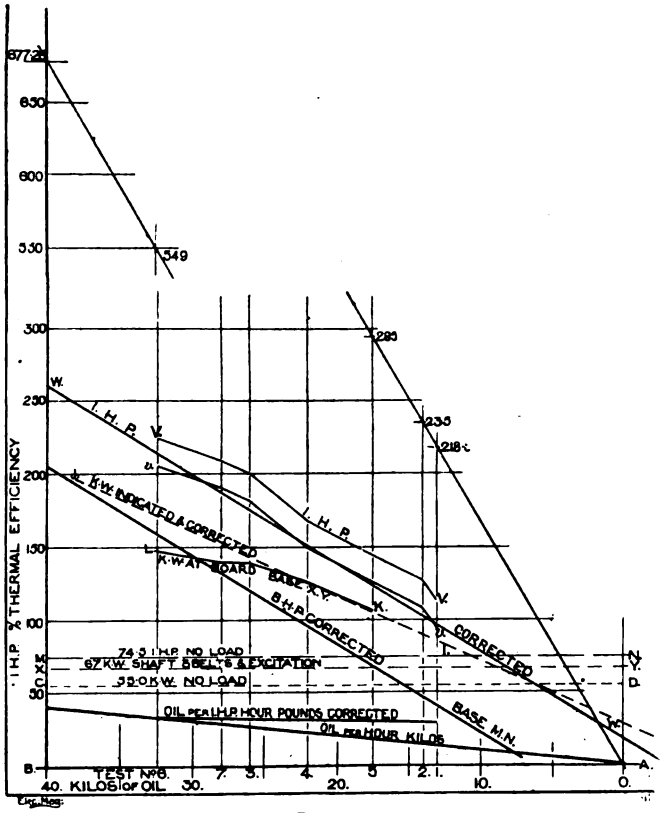


DIAGRAM 1.

shock as occurs where compression is only to five or six atmospheres, and the explosion pressure sends this up to perhaps twenty atmospheres. In this case there is an initial shock that is absent from a non-explosion engine, for the Diesel is non-explosive: it takes its heat in the shape of a flame of burning oil of a certain duration, whereas an explosion engine generates all its heat simultaneously. Where heat is thus generated on the dead centre, much of it passes directly into the jacket to heat water, whereas if the fuel is burned continuously as the piston moves, the heat is converted more directly into work, and less heat is wasted at the jackets.

Of course, thermo-dynamics as taught ignorantly would compel all heat to be supplied at maximum temperature at the dead point, but such teaching neglects practical facts and ignores the limitations of materials which compel engineers to compromise the conflicting claims of so-called theory. True theory, of course, recognises all the circumstances and becomes correct practice.

with temperature. At the full-load test No. 6 has therefore been added 25 per cent. to the coefficient of specific heat of gas, and the exhaust calories curve is corrected by adding 25 per cent. to it, and, at all other points, the proportion of 25 per cent. has been added as found by the curve in the lower part of the diagram. The fair line drawn through the corrected plottings ought, of course, to coincide with the curve of total heat supplied AR. Where it falls short the gap may be attributed to radiation loss, and where it exceeds the excess may be due to the water meter reading high, so that at low loads and smaller flows of water more heat is allotted to the jacket than really came out of it.

One of the mechanical niceties of engines which compress their working fluid to the maximum temperature, and obtain their power by maintaining the pressure of the compressed gas as it expands, is that there is no such sudden

In the diagrams herewith the statistics in Diagram 2 are got out on a basis of calories.

One calorie = 3.96 B.Th.U. In Diagram 1 the figures are on a basis of power units. The calories basis is simplest and best, and it seems useless, in testing work, to go further than give all results in calories, for it is with the calorific capacity of the fuel employed that the useful effort and the wastes are to be measured. In the diagrams actual observations are shown by dots on the broken curves. Corrected and faired curves are drawn in dotted lines.

The lesson to be drawn from the tests and from the amount by which the heat supplied in the oil is not exactly balanced by the sum of the calories accounted for,

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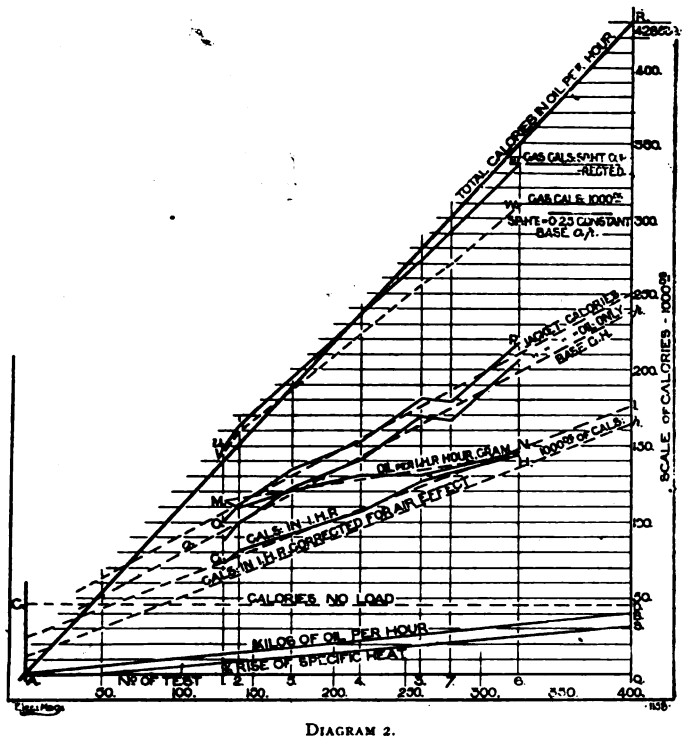


DIAGRAM 2.

is that the following must be capable of being found and measured.

(*a*) The i.h.p. so that the amount of heat converted into work may be known.

(*b*) The idle-horse-power whence the b h.p. is to be found by deduction.

These two demand accurate indicators.

(*c*) Thermometers on the compression pumps for the blast air, so that the temperature of the compressed blast air may be known and the amount of heat absorbed by the jacket may be thus found.

(*d*) There should also be thermometers on the water inlet to the blast air pumps, and on the water outlet from this to the main cylinder jacket. These would check the figures used or found in *c*.

(*e*) Correct water meters or meters of which the rating is known are required to measure the flow to the jackets.

(*f*) Indicators must be applied to the air-blast pumps, so that the work done in air compression may be known. Some of this power is given back by the expanding air in the power cylinder, and is properly to be deducted from the no-load i.h.p., in order to find how much of this is due directly to heat produced by the oil.

(*g*) Finally the exhaust temperature if measured enables the rejected heat to be known.

The i.h.p. at no load of an engine is generally supposed to be lost by friction. In the Diesel engine, however, it is converted into friction, into heat by compression of air, and into work by expansion of that air. The heat and the work appear either as area on the main indicator diagrams or as temperature in the jackets or in the exhaust. One is apt, therefore, to measure them twice over, and apparently to find a sum total in heat or work units greater than the heat supplied. The difficulty of exact measurement is also enhanced by the change in the specific heat of gases at high temperature. A careful analysis of the exhaust gas, measuring the steam in a given volume of gas, would enable an approximation to be arrived at out of this unknown quantity, though it would be simpler perhaps to measure the supply of dry air through a meter, for at present it is only a matter of more or less guessing to arrive at any estimate of the air supply owing to the fact that as the air enters the cylinders it is heated by the hot walls, and the full cylinder displacement is not secured. Though the Diesel engine thus affords interesting problems in heat calculations, it is a very simple matter to arrive at the plain commercial result of the amount of oil required for kilowatt hour or per b.h.p. hour.

In the engine tested the two cylinders measured 415 mm. diameter and 600 stroke, the air-blast pumps having two cylinders also single acting, and 200 and 70 mm. respectively by 230 mm. stroke. An intercooler between the two cylinders helped to separate all moisture from the air. At 222.05 i.h.p., the idle load being 74.45 the b.h.p. s 147.60. The oil consumption

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was 32.4 kilos. per hour or equal to 0.33 lb. per i.h.p. hour or 0.484 lb. per b.h.p. hour.

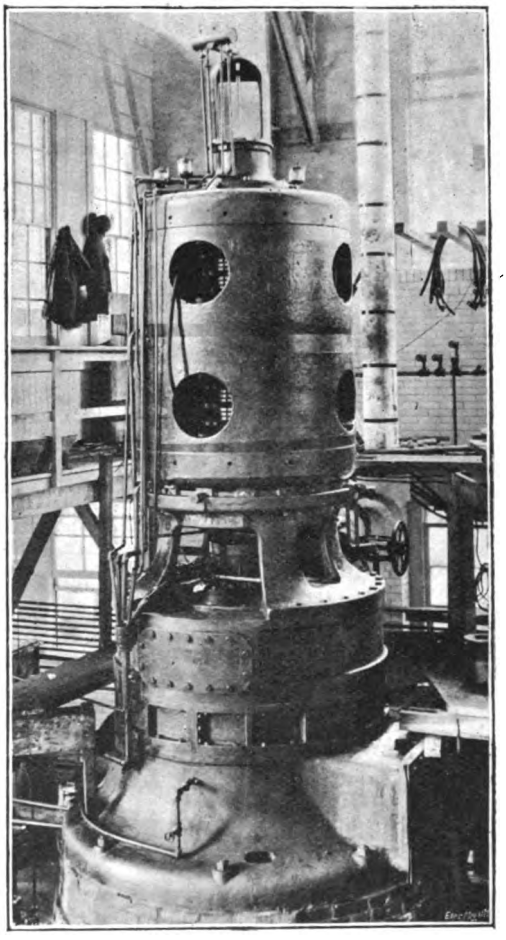
The apparent thermal efficiency per i.h.p. varied from 53.69 per cent. at $\frac{1}{3}$ load to 43.96 per cent. at $\frac{7}{8}$ load. Corrected as above explained, for the heat returned by way of the pumps, the thermal efficiency is shown to be 40 to 44 per cent. per i.h.p., and despite the long and constricted exhaust pipe, the efficiency per b.h.p. at full load after making all corrections came out as 29 per cent. The figure, of course, is what one aims to improve by cooling and enlarging the exhaust, so that the back pressure may be reduced and less atmospheric volume may require to be displaced.

As applied to electrical work the Diesel engine has already proved very convenient in helping the distribution system. It has been placed on a small plot of ground at a distant part of a tramway system to supply current and get over the severe drop of e.m.f. which is so often found to exist at the outer portions of tramway systems that have grown and extended beyond originally contemplated limits.

A New Turbo-Acyclic Generator.

By F. C. PERKINS.

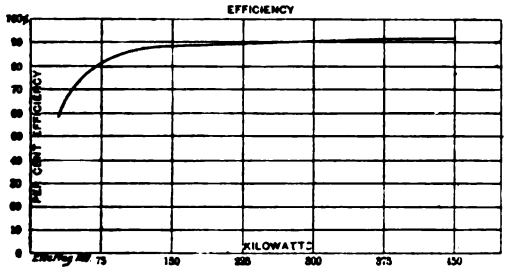
ALMOST interesting type of acyclic dynamo, frequently called a unipolar or homopolar generator, has recently been designed and constructed at Schenectady by J. E. Noeggerath. The accompanying illustrations show a 300-kw. 500-volt machine, and its armature direct connected to a Curtis vertical turbine built by the General Electric Company. The inventor claims that the statements made in recent magazine articles that the success of the acyclic generator is entirely due to the development of the steam-turbine are unfounded, since the Parsons and De Laval steam-turbines have been in operation abroad on a large scale for nearly a decade. He also holds that the acyclic motor-generator set offers many advantages, lowering the cost considerably on account of the high speed, while similar advantages offer themselves for the drive of blowers and pumps.



ACYCLIC GENERATOR AND STEAM TURBINE.

The Noeggerath acyclic dynamo has an armature of the cylinder type consisting of solid cast steel with a small number of straight conductors fastened on its surface and connected at both ends to sets of collector rings. There are twelve collector rings on either side of the armature mounted on shell, and assembled close together. Twenty-four contacts are made on these twelve collector rings, three brushes being located at each of eight large openings in the frame of the generator. The stationary circuit consists of twelve cables and the stationary winding, either set of collector rings, or the armature itself may be removed if desired without difficulty. The outside frame is of cast steel mounted on the top of the steam-turbine as shown in the illus-

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EFFICIENCY CURVE OF 300 KW. ACYCLIC GENERATOR.

tration. There are twenty-four conductors mounted on the smooth cast-steel armature, the torque being taken up by lugs projecting radially from the armature body while the steel binding wire is used for overcoming the centrifugal stress, and holding the conductors in place. The cast-steel field frame extends toward the shaft in three polar projections that enclose the armature in complete cylinders, the field coils being arranged concentrically around the shaft, setting up two primary fluxes diverging radially. The e.m.f.s generated in the armature conductors are constant in direction and magnitude as the armature revolves in a uniform field. By the frame conductors coupling up the collector rings the groups of single conductors are connected in series. The difference in pressure between full load and no load is only slightly higher than the drop due to the total resistance of the armature circuit, and the regulation has been found extremely good as shown by careful tests on the 300-kw. generator shown in the illustration. The full load losses in this turbo-acyclic generator were 28 kw. without bearing friction and windage, the total output being 300 kw. The regulation is from 6 to 12 per cent. the efficiency curve being flat, due to the small brush friction loss and small core loss. The sparking tendency at high densities and high speeds requires high brush pressures, but the increase of brush pressure does not decrease the drop to any great extent. With increasing speed there is a small increase of pressure drop at the brush contacts, but the friction loss remains practically constant at high speed. At high velocities the total losses remain nearly constant, and a higher current capacity may be maintained in the collecting system on account of the greater ventilation with higher speeds. This type of direct-current generator is said to be especially desirable for use with steam-turbines as it is necessarily a high-speed machine. The weight is about the same as other types of same output, but the copper weight is much lower while the cost of construction is considerably less, and there are no commutator troubles to deal with.

Electrical Power for Industrial Purposes.

IN our Editorial notes last month we referred to an important paper read by Mr. J. F. C. Snell before the North East Coast Institute of Electrical Engineers, giving some tables of considerable value on the subject of load factor and alternate-current and direct-current motor weights. These remarks we promised to supplement in this issue by further data, and we give these from the paper below. The first part of the paper deals with the isolated plant as compared with the concentrated station, and the author takes two instances of the former, supplying two large shipyards, as the basis for his comparisons. The plants in question, of which the fullest details are given, were a 672 kw. plant steam driven with direct connected generators and a 225 kw. plant comprising gas engines belted to the dynamos. The maximum load in the first case was 504 kw. and the load factor 22 per cent.; in the second instance the maximum load was 207 kw. and the load factor 14 per cent. The respective total costs were 1.08*d.* per unit and 1.173*d.* per unit, in the first case the period of operation being twelve months, and in the second four months. From these examples it is deduced that works

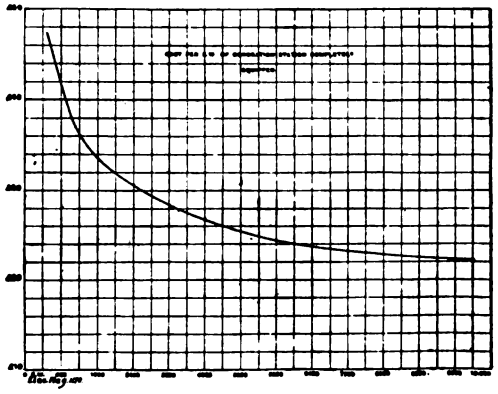


FIG. 1.

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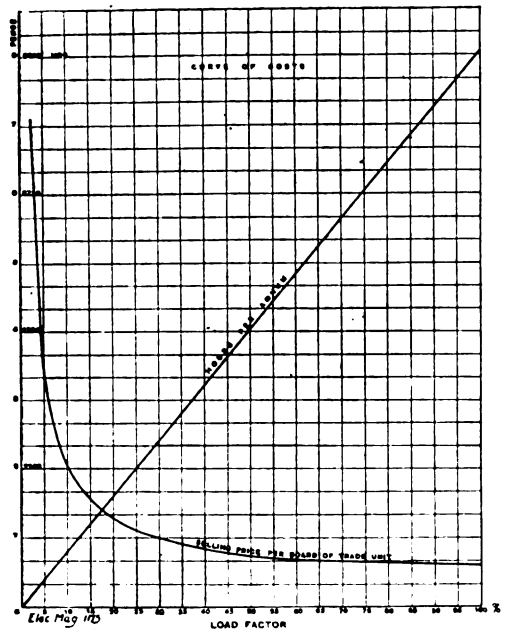


FIG. 2.

requiring 300,000 to 1,000,000 units per annum with a load factor of 20–30 per cent., will pay from 1.25 to 1*d.* per unit; further it is contended that in plants of this size the cost cannot be reduced below 1*d.* unless special conditions prevail, such as obtain with blast furnace gas. So much for the isolated plant for furnishing large works with power.

The question of furnishing energy to these large consumers from a concentrated plant of large capacity is then taken up. In this case the first saving is in capital cost per kilowatt, in support of which a curve (Fig. 1) was prepared showing the cost for a complete station, buildings, equipment (gas or steam engines) and 50 per cent. spare plant, for outputs up to 10,000 kw. It will be noticed that the smaller installations cost as much as £45 per kw., while the larger plants bring the outlay down to about £20 per kw. Another feature favouring the larger plant supplying many such consumers as factories, shipyards, engineering works, is the improved load factor obtained. The independent plants of such industrial establishments could not obtain severally load factors of 15 to 35 per cent., whereas in the combined station this figure could be increased to 45 or 55 per cent. This improvement is due to the non-synchronism of the maximum loads of the various works, giving what is known as the "diversity factor." Another curve (Fig. 2), which is valuable to all power-station men, accompanied the paper, and showed graphically the scale of prices at which a plant may reasonably expect to supply current. The curve was prepared from figures based on the practical capital cost of a large station equipped with modern plant, the remaining items of fuel, stores, wages and other establishment charges being taken from actual practical results. For the commercial aspect of power supply a special diagram (Fig. 3) had been introduced into the paper, which graphically compared the cost of small isolated plants and a combination of such installations into one station. The "diversity factor" is, however, not taken into account. By comparing the two diagrams a works manager can see at a glance the relative costs of his particular factory which will result either from his own plant or from the supply mains. The paper then enumerates other reasons for the purchase of power from an outside station. These are as follows:

Overtime can be better arranged. Power plant is not needed to be kept in readiness. Capital cost of plant saved. Space occupied by plant can be otherwise used. Antiquation of plant used need not be considered. Motors of 85 to 95 per cent. efficiency not likely to be superseded.

The concluding deduction is that above 50 per cent. load factor power can be more economically generated by a separate installation of plant, from which it is obvious that the majority of works having low load factor, such as commonly prevail, will benefit from co-operation by becoming consumers of a general power supply.

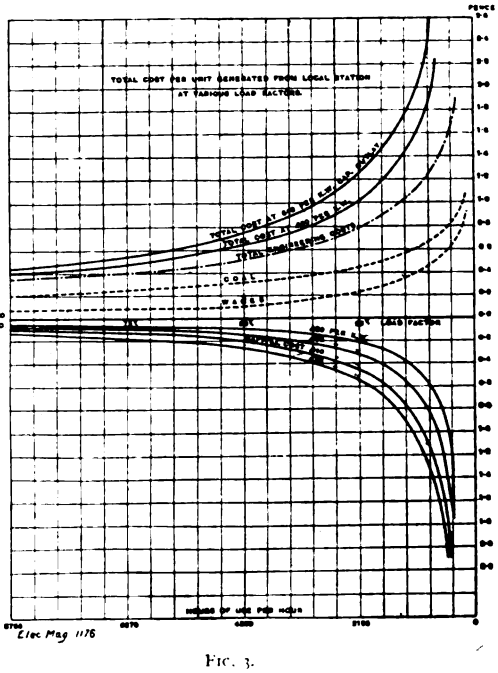
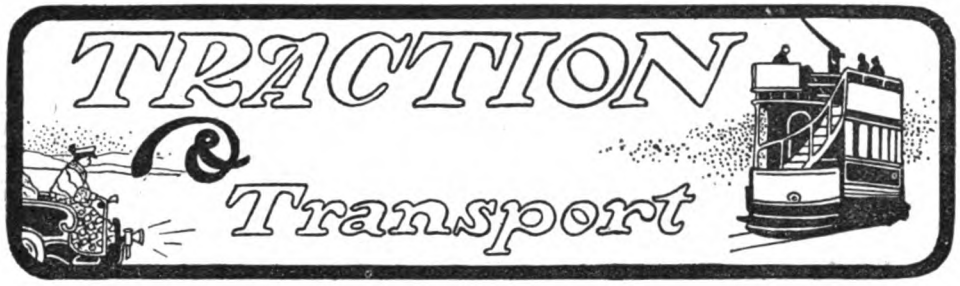


FIG. 3.

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A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

Statistics of the Growth of Electric Traction.

(Special Article).

By W. POLLARD DIGBY, F.S.S., A.M.I.E.E.



AT the end of 1904 there were in the United Kingdom 159 companies and 115 municipalities owning a track mileage of 1797 miles and a route mileage of 2890 miles of electric tramways and light railways, in which upwards of £107,000,000 sterling was invested. Only a decade previously—in June 1894—there were, according to a House of Commons return, 975 miles, for the operation of which 30,528 horses and 564 locomotives were required. In many towns the horse-drawn tram cars have been replaced by the electric car, in others the continuance of the old system is a mere matter of months or at most a few years. The steam-driven light railway has not been greatly extended, as most recent constructions have been electrically operated. As a matter of fact, it is probably difficult to say wherein the essential difference lies between a tramway and a light railway. Various definitions naturally suggest themselves. These need not be discussed, as the Board of Trade Returns do not make such a distinction, and as the concern in which the investor puts his money may be called by either name.

Dealing first of all with the capitalistic side of the question, the following figures are a copy of a table given in the latest issue of Mr. Garcke's *Manual of Electrical Undertakings :*

TABLE I.—CAPITAL INVESTED IN ELECTRIC TRACTION.

Year ending Dec. 31.	Companies.		Municipalities.		Total Capital.
	Number of Undertakings.	Subscribed Capital.	Number of Undertakings.	Authorised Capital.	
		£		£	£
1896	17	6,084,672	—	—	6,084,672
1897	30	7,436,173	—	—	7,436,173
1898	51	14,406,140	—	—	14,406,140
1899	66	19,639,530	11	1,169,429	20,808,959
1900	75	26,149,859	18	2,748,873	28,897,732
1901	125	39,522,183	47	10,519,543	50,041,722
1902	126	44,067,089	61	14,644,126	58,711,215
1903	156	61,606,509	92	21,295,771	82,902,280
1904	159	79,213,401	115	27,876,320	107,089,721

The figures of the above table are illustrated in Diagram 1. As compared with electricity supply, there are

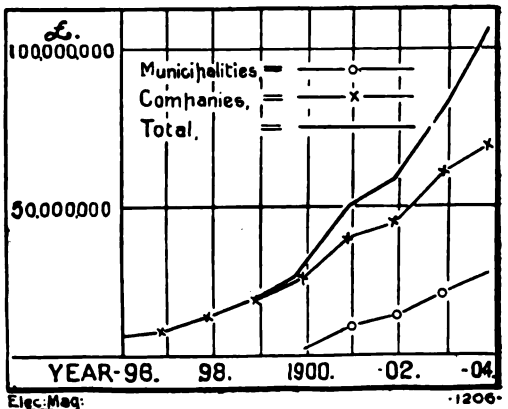


DIAGRAM 1.

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fewer traction undertakings owned by municipalities than supply systems. This of course is due to the fact that very small towns, in which electricity supply is commercially possible, do not offer commercial possibilities for electric traction within the municipal boundaries. The linking up of a number of such towns, and the construction of feeder lines from residential districts running into large industrial centres, is therefore in the hands of various limited liability undertakings.

In the returns for the year ending June 30, 1902, the Board of Trade first differentiated between the mileage of the various methods of traction in vogue in the United Kingdom so far as the length worked is concerned.

Date of Return.	Electric.	Steam.	Cable.	Horse.
1902 (*June* 30) . . .	871	156	35	384
1903 (*June* 30) . . .	1258	140	30	333
1904 (*Dec.* 31 *of* 1903 *for companies, and March* 31 *of* 1904 *for municipalities*) . .	1462	103	30	235

The above figures are illustrated in Diagram 2. The rearrangement of the

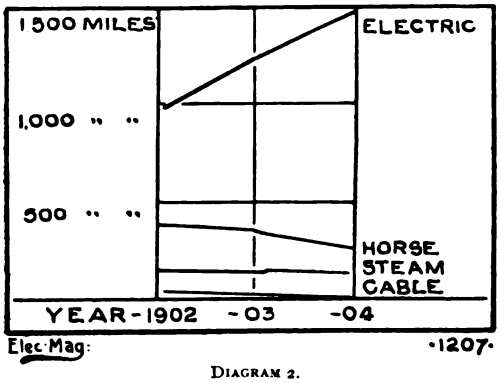


DIAGRAM 2.

period covered by Board of Trade tables does not show even the full value of the progress during 1904. Despite this deficiency, it is manifest that whatever have been our shortcomings in the past in regard to electric traction, the present is an era of tremendous electrical activity. Striking though the foregoing figures are in regard to the elimination of the horse-drawn or steam-driven trams, others are yet more significant (Diagram 3).

Year.	No. of horses.	No. of engines.
1896 ...	35,231 ...	568
1897 ...	37,342 ..	492
1898 ...	38,777 ...	589
1899 ...	44,171 ...	584
1900 ...	37,481 ...	558
1901 ...	34,422 ...	527
1902 ...	24,120 ...	388
1903 ...	20,005 ...	334
*1903-04 ...	15,353 ...	249

* New classification of period.

It is to be regretted that no published returns give the number of electric cars or their seating capacity during the respective years. From the municipal returns published by the *Electrical Times* it would have been possible to give the number of cars owned by municipalities alone during each year. This would have only been a very partial indication as municipal traction activity accounted in these early years for a relatively small proportion of the capital expended. The financial position of street and road tramways and light railways as a whole during each financial year ending June 30 may be judged from the table below.

The most notable feature in the above figures is the remarkable decrease in the working expenses since 1901, a decrease which can only be attributed to the economies due to the increasing introduction of electric traction. With the advent of electric traction and the spread of tramways and light railways generally, both car mileages and the number of passengers carried have greatly increased (Diagram 5).

It is to be regretted that the number of passengers carried by the electrical

	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1903-04.
	£	£	£	£	£	£	£	£	£
Gross receipts . .	4,152,016	4,235,593	4,560,126	4,879,602	5,445,620	5,961,062	6,679,291	8,070,042	8,604,884
Working expenses .	3,105,511	3,198,444	3,507,895	3,675,559	4,075,352	4,525,179	4,817,873	5,511,259	5,692,774
Nett receipts . .	1,046,505	1,037,149	1,052,231	1,204,043	1,370,277	1,435,883	1,861,418	2,578,783	2,912,110
Percentage of nett receipts per £100 capital expended . . .	6.90	6.98	6.38	6.47	6.30	5.35	5.90	6.19	6.25
Ratio of working expenses per £100 of gross receipts . .	74.73	75.52	76.92	75.32	74.84	75.93	72.12	68.12	66.15

TABLE SHOWING FINANCIAL POSITION OF STREET RAILWAYS SINCE 1896.

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Year ending June 30.	1896.	1897.	1898.	1899.	1900.	1901.	1902.	1903.	1903-4.*
Passengers carried	759,466,047	788,569,666	858,485,542	924,820,247	1,065,374,347	1,198,226,758	1,394,452,983	1,681,948,655	1,799,342,673
Car mileage .	81,252,845	84,643,728	90,593,716	96,078,503	108,665,661	123,176,561	145,127,423	178,684,280	194,901,327
Passengers carried per car mile .	—	—	9.63	9.63	9.82	9.73	9.65	9.19	9.22

* New classification of period.

TABLE OF CAR MILEAGE AND PASSENGERS CARRIED.

cars as against those carried on other cars are not separately enumerated. There are several new features of much interest in the latest Parliamentary return on the subject which give rise to a hope that succeeding analyses will contain further summary tables. A rather striking table is given in the prefatory memorandum which summarises the returns of three typical years in different periods: the following items are quoted from this return:

Period.	Horse.	Steam.	Electric.
	1879.	1898.	1903-04.
Passengers carried per mile of route open . . .	469,641	806,703	977,591
Average fare per passenger .	1.84*d.*	1.23*d.*	1.11*d.*
Capital expenditure per mile of single track open, all items	£9,877	£10,469	£16,018

The following figures are not without interest to electrical manufacturers. In the United Kingdom in the year ending 1903-04, £89,287 was expended on the general repairs and maintenance of the electrical equipment of the line, £498,183 was spent for the repairs and maintenance; while the cost of tractive power (either in actual payment or in cost of energy produced) was £1,331,276. For this sum 211,112,476 units were obtained,

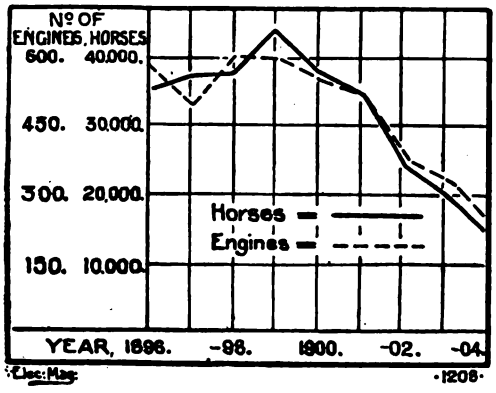


DIAGRAM 3.

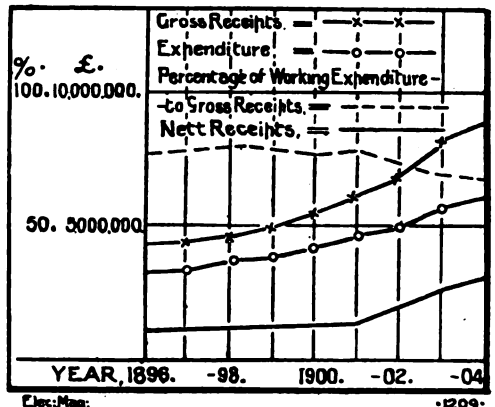


DIAGRAM 4.

the cost thus averaging 1.51 pence per unit. No less than 7,132 electrical cars were in use as against 2,336 non-electric cars. Of the capital expended £3,743,289 was devoted to the electrical equipment of the line, and £1,416,387 to the electrical generating plant; the capital cost of the entire number of cars in use was £4,148,144.

Every reader of THE ELECTRICAL MAGAZINE is well aware that tramway systems are not the only form of electrical activity. Tube railways, and converted steam railways such as the Metropolitan, and sections of the Lancashire and Yorkshire, North Eastern Railways already electrified are abundant evidence to the contrary. At the time of writing 85 route miles of electric railways (as distinguished from light railways and tramways) are actually under operation, 21 miles are under construction in London alone, and 102 miles are being converted from steam to traction, while a further 66 miles have been authorised.

According to the Railway Returns for the United Kingdom for 1903 (when lines worked by electric power were first separately enumerated), 88,634,444 passengers were carried on such lines in

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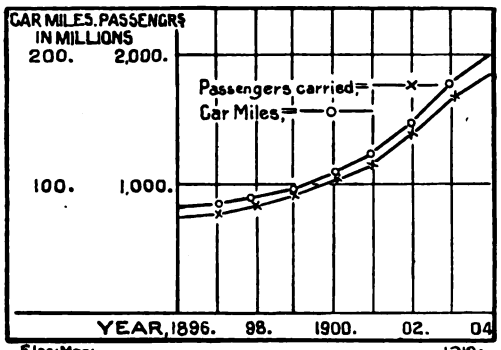


DIAGRAM 5.

England and Wales. The working expenditure amounted to £432,313, the total receipts to £742,333, a percentage proportion of 58 as against 63 for steam-driven railways. The number of electric locomotives was 96 and the number of vehicles of other descriptions exclusive of locomotives was 661. Succeeding returns will permit of very interesting contrasts in this connection.

The electrification of main line railways is still the problem of the near future. The electrification of suburban lines is the recognised task of the present. The growing importance of tramway competition, which, in eight years, has more than doubled its number of passengers, while the third-class passengers on railways have increased by only 15 per cent., has awakened railway directors to the fighting of their competitors by methods of drastic alteration. The electrically driven suburban train will displace the tank locomotive, as surely as the electric tram has displaced the steam-driven tram. To describe the outlook, therefore, of the electrical engineer and manufacturer as tremendous in its possibilities is in no way an exaggeration.

A SOUVENIR EULOGY.

Mr. M. HAYASHI, son of the Japanese Ambassador, sends his opinion, as follows:

"The Special Souvenir Number of THE ELECTRICAL MAGAZINE *was forwarded from London and has safely arrived here to-day. It gives me much interest and pleasure to see the fine collection of the photos followed by the clear description, and as well as the various opinions of the members of the tour."*

*Street Railway Conditions in Massachusetts.**

DURING the year ending September 30, 1904, of seventy-four companies operating street railways in Massachusetts, thirty failed to earn expenses and fixed charges; twenty-five paid dividends; of the twenty-five which paid dividends, fourteen earned them during the year. Five companies have been in the hands of receivers. Very few companies besides keeping their railways in good repair reserved for depreciation what prudent management would require. Generally present necessities only have been met, the future with its inevitable expense of replacement and reconstruction being allowed to look out for itself.

The board of railroad commissioners of Massachusetts prepares a yearly list of companies which appear from its returns to have properly earned and paid a dividend of at least 5 per cent. for the five years immediately preceding. Thirteen companies were found to be entitled to a place upon the list submitted in January 1903; the list of January 1904 contained the names of twelve companies; that submitted this year contains the names of ten companies.

Experience has shown that with the more expensive roadbed and equipment, the heavier rail and larger cars, there has not been the corresponding and expected development of permanent business. Operating cost, in heating cars and in repair and renewal of plant, has proved larger than was expected. With the new accommodation and the nearer approach to railroad conditions has come the increased demand of the public for expenditures in the interest of safety and comfort which had not been counted upon, as for example, in construction of double track, instalment of signal systems and establishment of waiting-rooms. Upon some railways fares have been raised, and with encouraging results, but this action is usually unpopular and is often taken at the risk of lessening the volume of business. It is, moreover, at times complicated by agreements made between companies and town officials

* *Electrical Review, N.Y.*

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when locations and privileges in the streets were granted.

Another incident of the present situation has been the enforcement upon certain systems of a seemingly arbitrary distinction between the long and the short-distance ride, to the provocation of the through traveller, who is loath to admit that there is any justification for it. The zone system has never been favoured in Massachusetts. Instead there has been adopted the five-cent fare within city and town limits, in some cases between centres of adjoining towns. As new grants of location have been sought the five-cent fare has been made good for greater and greater distances, frequently through the use of transfer checks. This low fare promotes a better distribution of population in large communities and is now conveniently paid and collected, while the company has been enabled to reap a profit in the frequency with which cars have been filled and refilled with persons taking short rides. In one notable and exceptional instance this fare covers five cities, which were deemed to be so closely connected as to make practically one continuous community, and so to give the company the advantage of continually changing patronage from point to point. The attempt, however, upon interurban lines to maintain these local concessions and at the same time to establish a sort of mileage basis for through travel, with arbitrary fare limits, has naturally led to frequent complaints from those who think they are unjustly denied privileges which are given to others. Much study has been and is being given to the establishment of a more satisfactory system of fares upon these railways, but as yet the problem remains unsolved.

Table of Statistics for 1904 and the preceding year.

Year ended Sept. 30.	1904.	Changes from 1903.	
Mileage single track.	$2,724,312	Inc.	$53,580
Gross assets . .	140,843,740	Inc.	1,979,525
Gross liabilities .	136,049,486	Inc.	2,928,075
Capital stock . .	68,542,038	Inc.	137,558
Funded debt . .	46,674,884	Inc.	5,263,384
Current liabilities .	17,434,452	Dec.	2,547,059
Surplus . . .	3,152,868	Dec.	976,952
Gross earnings .	26,207,247	Inc.	666,430
Operating expenses .	18,397,291	Inc.	877,924
Net earnings . .	7,809,956	Dec.	211,488
Dividends . .	3,214,496	Dec.	371,752
Interest, taxes, and charges . .	6,363,830	Inc.	358,462
Surplus for year .	*216,383	Dec.	233,051
Passengers carried .	520,056,511	Inc.	15,394,268

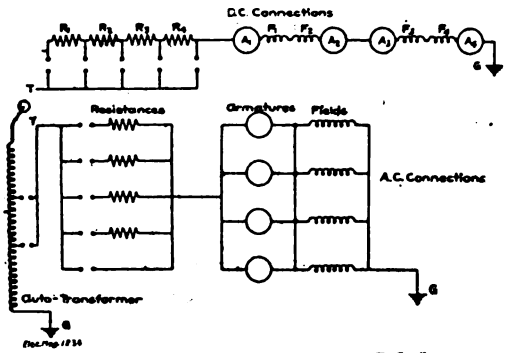
* Deficit.

Control of Westinghouse One-Phase Railway Motors.

IN our last issue a brief description was given of the first commercial one-phase railway put into operation in the United States. Particulars are now available of the method of control adopted on that line and these will doubtless prove of interest. It will be remembered that the standard control system adopted by the Westinghouse Company for its one-phase railway motors included an induction regulator which gradually raised the voltage impressed on the motors to its full value. This method is both economical and simple, and was one of the chief features of the control. On the Indianapolis-Cincinnati Railway, however, it has been found necessary to adopt rheostatic control because the motors must operate on the direct current 500 volt system at the Rushville end of the line. The new system has consequently been launched with a mongrel equipment which is none the less interesting or typical of what can be done in special circumstances. The equipment of the car comprises four alternate-current series motors 75 h.p. each controlled from the following auxiliaries: an auto transformer wound for 550, 1,650, and 3,300 primary volts of 250 secondary volts, a reversing switch motor cut out switch, change over switch, a complete multiple unit switch system with necessary controllers, rheostats, batteries, air compressors, and reservoirs. In addition the car is fitted with air and hand brakes and two trolleys, one a bow type for high-voltage service, and the other of the wheel pattern for low-voltage operation.

The acceleration of the motors is effected entirely by the multiple unit switches which are of the Westinghouse standard pattern operated by compressed

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SIMPLE DIAGRAM OF CONNECTIONS, A.C. AND D.C. CONTROL.

air, which is admitted by electro-magnetic valves. The control circuits may receive power in three forms: (1) as 3,000 volt alternate current; (2) as 500 volt alternate current; (3) as 500 volt direct current. From the alternate current supply the motors are connected in parallel and controlled from the auto-transformer by which and by resistances the voltage of the motors can be gradually raised and lowered. This control is possible without series paralleling the motors as will be seen from the attached diagram of connections. The same diagram also shows the connections, in simple form, of the direct-current motors which, of course, conforms to standard practice. To provide against failure of the air supply on the different routes, the compressors are in duplicate but driven by alternate-current and direct-current motors respectively, both types being series wound and automatically controlled by the air supply.

The collecting devices are also distinct for both high and low voltages, but it is in the former that the chief interest centres. The high-pressure collector is the bow pattern specially designed for this class of work, for which it has been also adopted as standard. The bow carries a large, flat aluminium shoe, which is pressed against the underside of the trolley-wire by four springs attached to a rectangular frame at the upper end of which the bow is pivoted. The base is mounted on large porcelain insulators which in turn are clamped to a wooden support heavily insulated from the car roof. A compressed air cylinder is attached to the frame and all movements of the bow can be made by the motorman without risk of shock. This is a much needed precaution and one which has been very efficiently taken. The cars operating on the Indianapolis and Cincinnati line are certainly unique in the matter of equipment and control, as will be gathered from the above description. It would seem impossible that such a diversity of apparatus could be mounted compactly and easily under the body of a car, with complete provision for accessibility and repair of the multitude of parts which make up the entire equipment. Yet it has been done and successfully in this case. We shall, however, look forward to the appearance of the first car, equipped with one-phase apparatus alone, without the compromising presence of direct-current appliances of any description.

FURTHER TRIBUTES TO THE SOUVENIR ISSUE.

Space compels us to omit many other letters, but the following are a few extracts expressing the feeling of all:

L. G. E. MORSE writes:

"It is a most valuable diary for those who had not time to make notes of all they saw."

MR. D. BATES, M.I.E.E., of the British Insulated Wire Company, expresses a valuable opinion of the Souvenir issue:

"The Souvenir Number does you very great credit indeed, and the amount of work entailed in its production must have been enormous."

W. H. SCOTT, of Laurence, Scott and Company, Ltd., Gothic Works, Norwich, writes:

"I congratulate you on the Souvenir Number, and enclose small cheque for 12s. 6d. and order for your Magazine."

W. A. BARNES, M.I.E.E., of the Lancashire and Yorkshire Railway Company, says:

"I have seen the Anniversary Number and think it does you and your staff great credit indeed. It makes a very valuable souvenir of our outing."

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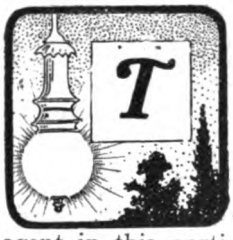


Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

*Electrical Thawing of Water Pipes.**

By M. A. SAMMETT.

Transformer Thawing Outfit.



THE thawing out of frozen water pipes by means of electricity is a new application which is becoming widespread. Electricity as a thermal agent in this particular use secures best results in the shortest possible time, leaving the pipes intact, making excavations unnecessary and furnishing the cheapest means to restore water supply. While by no means a new method, it is now a necessary adjunct of every electric operating company, and the growing need of transformers with a capacity for heavy currents has forced transformer manufacturers to place on the market special transformers for this purpose.

Prior to the special transformers, it was necessary to use apparatus of very large capacity, in order to be able to obtain heavy currents, so frequently 40 kw. transformers were used with a water rheostat in series with the secondary coils, thus making the outfit very bulky.

The Montreal Light, Heat and Power Company at the present time has four transformer thawing outfits, of 10 kw. capacity (normal) load, similar to the one described herewith. These are doing most effective work. The transformers are of special design made by the writer, with the object of securing full capacity of the transformer at various voltages. So far, the various transformers designed by the leading manufacturers have as a means of regulation either a reactance in series with the secondary coils, or a magnetic shunt on the core, or taps on the secondary winding. In every case, when using a current at a fractional secondary voltage the transformer capacity is lessened, since the secondary current is a fixed quantity.

In the case of the transformers of the Montreal Light, Heat and Power Company

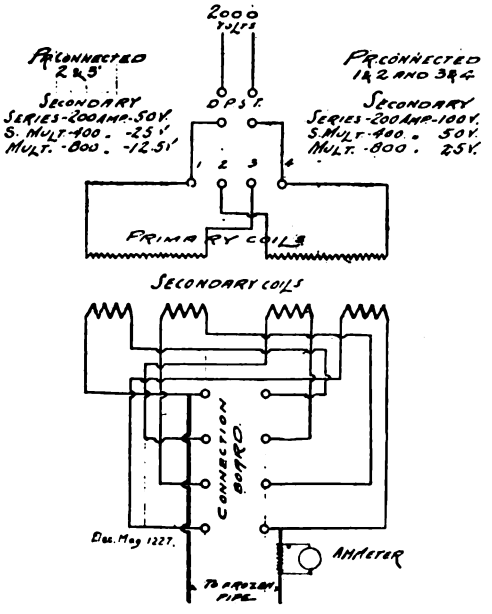
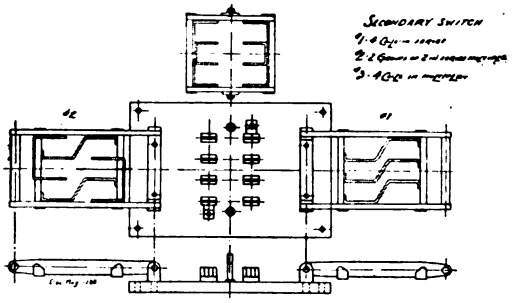


DIAGRAM OF CONNECTIONS.

* *Canadian Electrical News.*

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VIEWS OF CHANGE OVER SWITCH.

above mentioned, there are four secondary coils. The start and finish of every coil are brought out to a connection board, and various combinations of the four coils are obtained. The three switches engage one at a time with the connection board, and the different combinations are obtained, *i.e.* four coils in series multiple, and all coils in multiple. This arrangement will allow the use of full capacity of the transformer with every combination, so in the case of the four coils in series a current of 200 amperes at 50 volts is secured. With the combination of coils in series multiple, 400 amperes at 35.0 volts are secured, and with all coils connected in multiple, 800 amperes of 12.5 volts are available. The primaries are connected on 2,000-volt distributing circuits. As the transformers operate intermittently, in an atmosphere of very low temperature, considerable overloads to an extent of double the load are permissible over a period of one half an hour.

Besides the three combinations on the secondary coils, the transformer is designed so as to allow the placing of the primary coils in multiple and thus enable one to double the secondary voltages for every combination. To secure these results it was necessary to design the transformer with a low magnetic density, keeping the iron at a comparatively low point of saturation. Connecting the primary coils in multiple the following would be the voltages on the secondary side: 100 volts, 50 volts, and 25.0 volts. These voltages give a range wide enough to take in pipes from large mains to small service pipes, and in a number of cases it was found that in the work on service pipes of ½ in. in diameter, and about 200 ft. long, the 50 and 25.0 combinations were used with very good results.

In starting the work on thawing out, a switch of the combination of the 50 volts is used first, and as the current comes up to about 200 amperes, this switch is opened and the switch of the series multiple combination is closed, enabling 400 amperes to be taken off the transformer.

The average time required to thaw out frozen pipes with this outfit is from two to three minutes, and in one instance a water pipe was thawed out in as little time as fifteen seconds. This commends itself very highly as to the efficiency of electric current in this application.

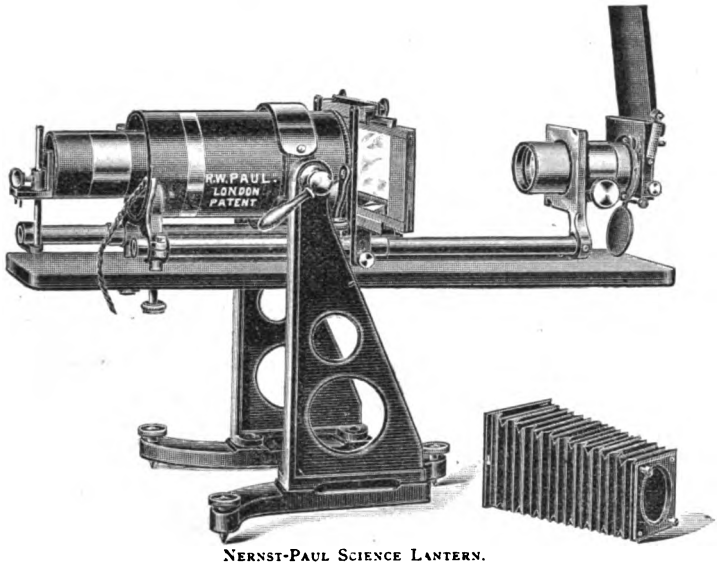
The switch used in connection with these transformers as shown in the sketch is composed of a connection board with eight studs to which the secondary coils are connected. The right and left hand switches engaging with this board are made of heavy copper bars and engaging with the board secure the various combinations as mentioned above. The third combination of all secondary coils in multiple is secured by a third switch which is placed in position by the use of two guides.

In the writer's estimation, this method of securing variable voltages is most satisfactory, for the reason that it allows the operator to use the transformer at full capacity, rendering it suitable for work on small service pipes, as well as pipes of large cross section in heavy mains.

A New Projector Lamp.

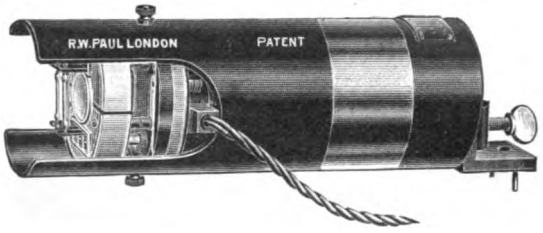
FOR a number of years there has been no intermediate illuminant between the incandescent vacuum lamp and the arc lamp for optical lantern purposes. The former, even if made with a special filament, failed to give satisfactory results both in the amount of light emitted and in the concentration of that light. The latter, though satisfactory for large lanterns, could not be readily adapted for all purposes, and consequently was only serviceable in special cases. The introduction of the Nernst lamp opened up possibilities for its adoption to optical projector work as a medium between the small glow lamp and the cumbersome arc. A number of experiments have been conducted and a form of Nernst lamp evolved which seems to meet the case exactly. This work has been undertaken and brought to a practical issue

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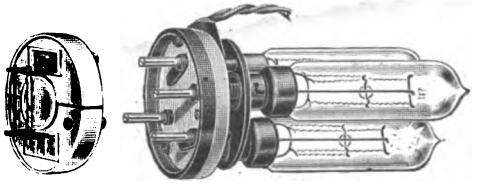


NERNST-PAUL SCIENCE LANTERN.

by Mr. R. W. Paul, of 68 High Holborn, with the most complete success. The projector lamp, of which we give illustrations, is cylindrical in form and exceedingly compact. It is made in two patterns—a long type, in which the glowers and their resistances are contained within a single case, and a short pattern, in which these two portions are arranged separately. This modification was thought necessary to enable the lamp to be used in existing lanterns of short form. The burner, which may be seen separately in the illustrations given, is detachable from the lamp, having sockets at the back engaging with pins in an insulating base. The glowers, of which there are three, are supported on small brackets at the front of the burner base, and may be detached from the brackets for easy renewal. To facilitate this, small connecting plugs are fitted to each glower. The steadying resistances fit into bayonet socket holders at the back of the supporting base. The complete arrangement is enclosed in a brass body fitted with a bracket which may be clamped to any ordinary supporting pin. After experimenting with a number of heaters it was decided to abandon the idea of warming the glower electrically. To start the lamp a small spirit lamp is used, which heats the glowers after the current has been switched on. In their normal position the glowers are vertical, but for convenience in heating them the entire body of the lamp can be revolved to bring them into a horizontal position from which the lamp flame may play evenly upon the glowers. The illumination obtained is sufficient for clearly showing a disc of 10 ft. diameter in a moderate sized hall. A light of high actinic power is procured which makes the lamp specially suitable for photographic enlarging or printing. Lecturers and demonstrators at technical institutions will be interested in the application of this lamp to a special science lantern. This we also illustrate, and it will be seen that the arrangement is very compact, the apparatus being mounted on trunnions. Vertical or horizontal projection is thus made possible, and the change from one position to the other can be effected immediately. A slide stage with lightning carrier is so fixed in front of the condenser that it can be instantly removed. The bellows front is also detachable, leaving a clear space for special apparatus and experiments to be projected. This apparatus can be fixed to a board secured by thumb screws to the metal frame of the lantern, and spare boards with apparatus ready fixed can be quickly brought into position. We understand that the device has been well received, and that large orders have been booked from technical institutions throughout the country. We need hardly remind our readers that Mr. Paul also specialises with optical arc lamps for projector purposes.



Projector Lamp complete.



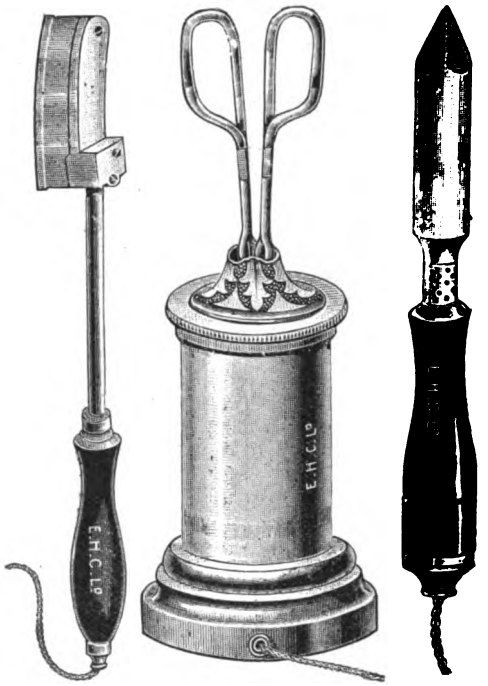
Burner and resistances.

NERNST-PAUL PROJECTOR LAMP.

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New Electric Heating Appliances.

ELECTRIC heating makes but slow progress, but such improvements as are affected generally constitute an advance on previous practice. The average layman does not give the electric heater full credit for all its economies, as in reckoning these he looks only at the current consumption of the heater, without regard to the time element. This latter is the key to the whole position, much as it is with gas. No sane person would think of using a gas cooker after it had served its particular purpose at the time, and similarly an electric cooker is only needed as long as there is work for it to do. Consequently the chief economy of the electric heater, whether it be used for kettle, saucepan, stove, or oven, lies in the fact that when not needed it is costing nothing. The electric heater is to a fire what a motor-car is to a horse—always at command but wasting nothing when out of service. In the light of these remarks we may refer to the new heating devices of the Electric Heating Company, 3 Holborn Place, W.C., who have just introduced a number of novelties in this direction under the appropriate name of Phœnix. We give illustrations of a few of these, and they will convey the best possible impression of the design and compactness of the apparatus. The hot plates are extremely compact and can be used for a variety of purposes, boiling kettles and saucepans, frying, grilling, &c. A quart of water can be brought to boiling point with a Phœnix Heater at a cost of one farthing. It would cost more for firewood to light a fire to obtain such a result. The company's range of specialities is a very wide one, including both the smallest and largest types of heater for warming rooms, &c., and every conceivable class of utensil for cooking and domestic use. In each case (except the smaller articles) every provision is made for regulating the heat by contact plugs, and any temperature from boiling to simmering point is available at all times. We have had a small kettle in use regularly for some time now and find it extremely handy in brewing the editorial "cheering cup." Constant use also suggests a point at which the current can be cut off, the residual heat, bringing the water to a boil and keeping it hot for some considerable time. This circumstance indicates how marked economies can be effected after the particular utensil has reached a serviceable heat for the purpose in view, the current being switched off and the heat already stored by its agency utilised to best advantage.



SOLDERING IRON AND CURLING IRON HEATER.



ELECTRIC CHAFING DISH.



ELECTRIC GLUE POT.

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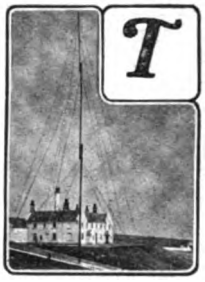


For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

Municipal Telephony.

(Special Article.)

By ALFRED R. BENNETT, M.I.E.E.



THE question whether it is proper for municipalities to undertake the working of telephone systems has been much canvassed. In order to justify such enterprises it is necessary to show that corporations can produce results which are in some way or other superior to those possible to a Government or a private undertaking. If a local authority can give a service satisfactory to its subscribers while charging rates sensibly lower than those which ruled before it came into the field, then the case for municipal telephones may be held to be established. So far as experience has gone it would seem that local authorities have not only succeeded in satisfying their subscribers, but have also materially reduced the cost to them. The Blue Book of the Glasgow Telephone Inquiry of 1897 clearly shows that the service at that date, apart from any question of cost, was considered entirely unsatisfactory by a large majority of the subscribers, and it also shows that the rates charged in Glasgow were very high. The nominal rate was £10 for a first connection and £8 10s. for a second connection, but these figures applied only to the centre of Glasgow. In the suburbs twice and more than twice was exacted. For instance, it was given in evidence that an ordinary exchange connection in Govan cost £20 per annum; in Partick £22 10s., and in Rutherglen £23. We had here the not unusual combination of high rates and inefficient service, while the total number of exchange lines in a population of about one million only reached to 5,036. The Corporation came on the scene in 1900 and made a rate of £5 5s. per annum, irrespective of locality and of distance, which meant a reduction at one coup of more than one-half of the old average. At the same time, they put down the most modern cables and instruments. After four years' working, so far from having lost money, the Corporation finds itself with a balance in hand, while the number of telephone subscribers has gone up to about 25,000. In considering the result to the ratepayers it must be borne in mind that the Corporation in constructing its system has brought into existence a new rateable value of considerable importance. The Corporation Telephone Department have already paid several thousand pounds in assessments on its property, which is found money to the ratepayers. It has also forced the competing body, by compelling it to improve its service, lower its rates and add to the number of its subscribers, to make a much larger contribution to the rates than it did before the competition, so that the ratepayers benefit from this reflected result also. If the amount saved to Glasgow citizens in the shape of reduced telephone rates be likewise reckoned as a benefit, then the city may claim to have gained a very large sum indeed, because the 5,000

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subscribers existing in 1897 paid at least £60,000 in the name of rentals, while 25,000 subscribers in 1905 pay only something like £125,000. Had the old figure been maintained the cost of the service to 25,000 subscribers would have been £300,000 instead of £125,000, a yearly difference certainly worth considering. So the inauguration of municipal telephones in Glasgow has produced nothing short of a financial earthquake in the telephone world. Similar results have followed the installations of municipal telephones at Portsmouth, Brighton, Swansea and Hull. In each place the Corporations are able to work at figures approaching one-half of those which used to prevail; in each case their competitor has reduced his charges below the rates fixed by the Corporations, and in each place a new rateable value has been created, of which the ratepayers obtain the benefit. In all the places named the old charges were £10 for a first and £8 10*s.* for a second connection, whereas the Corporations find it possible to more than make ends meet on tariffs which do not produce more than an average receipt of some £4 10*s.* per line per annum, which is approximately a reduction of one-half. It has been urged that they only do this by neglecting to provide adequate depreciation funds, but it must be remembered that the municipal services are of very recent origin, and that some have not even completed their first year's working. Under such circumstances it might be thought too soon to expect much provision for depreciation, but those local authorities who have had their telephone services working for two or more years have already been able to commence depreciation funds by devoting their surplus revenues to that object. Although the Post Office estimate of the life of telephone plant is thirty-six years, the English local authorities have to pay back their loans in twenty-five years, and Glasgow in thirty years. As the whole of the capital is thus repayable a long time before the life of the plant is exhausted, the annual surpluses earned will amply provide for any depreciation that can fairly accrue. As depreciation is only reasonably chargeable when the plant wears out within the loan period, these accumulated surpluses may be regarded more as a reserve or insurance against possible obsolescence of part of the system than as depreciation proper.

The first local authority to enter the telephone field was the State of Guernsey, which commenced to operate its exchange in July 1898, and is consequently in its eighth year of working. The Guernsey enterprise differs from all the rest because there is no competition, the National Telephone Company never having started a service in the Island. The Company wished to charge £8 per annum, a rate which was justly considered prohibitive. The State's tariff is the lowest in the kingdom and closely approaches the lowest point touched anywhere. The charge for what is substantially an unlimited service is £5 per annum. There is a second tariff of £2 5*s.* per annum and a halfpenny for each outward call, and a third tariff of £1 10*s.* per annum and a penny for each outward call. At first sight, in the light of the figures charged in non-competitive towns in Great Britain, such figures appear preposterous, but the Telephone Department continues year after year to increase its profits and its reserve. The material used in constructing its system is the best obtainable and the service it gives to its subscribers is universally admitted to be satisfactory. Guernsey therefore constitutes the best example of what municipal telephony is capable of. In other centres it has to reckon with very active competition, which forces the hands of the Corporations sometimes in directions which but for it would be avoided. Guernsey has been free to do its best to comply with the local requirements, and to show what intelligent local management can effect. Every town and district possesses its own special telephonic characteristics which can only be properly appreciated and catered for by those who understand them. A centralised management is a mistake in telephony; no person with expert knowledge will contend that Guernsey would have become, as it has done, the best telephoned area in the kingdom had its telephone system been prescribed and managed from London. In that case it would have been treated exactly like Orkney or the Isle of Man, and, like those places, would have suffered owing to ignorance of their special requirements.

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The following are the maximum charges imposed by the several local authorities owning telephones:

	£	s.	d.	
Guernsey	5	0	0	per annum.
Glasgow	5	5	0	,,
Portsmouth	5	17	6	,,
Brighton	5	10	0	,,
Swansea	5	0	0	,,
Hull	6	6	0	,,

These rates are for a direct, exclusive metallic circuit line to the Exchange, with unlimited number of calls. The rates for toll lines and party lines are much lower.

The number of telephone stations working, the capital expenditure and the average cost of the lines about the close of last year were as follows:

	No. of Working Stations.	Capital Expenditure.	Average Cost per Station.
		£	£ s. d.
Guernsey	1,375	23,590	17 3 1
Glasgow	12,136	297,990	24 11 0*
Portsmouth	2,043	36,071	17 12 0
Brighton	1,638	39,760	24 6 0†
Swansea	1,067	18,031	17 0 0
Hull	995	26,182	26 0 0†

* The cost at Glasgow was increased by the adoption of underground distribution to subscribers' offices and the laying of long underground junction lines to the suburbs.

† Installations incomplete. Systems laid out for 2,000 lines; above average costs will be much reduced when full number provided for has been joined up.

The profits made, according to the last published accounts, are as follows:

	£	s.	d.
Guernsey	681	16	5
Glasgow	5,743	7	5
Portsmouth	1,259	13	0

The others have not yet been in operation for a complete financial year, but both Brighton and Swansea will attain that position at the end of the current month, while Hull will not complete a year until March 31, 1906.

In constructing the municipal systems efficiency has ever been the first consideration although, as the figures show, it has also been found possible to combine with it no slight degree of economy. The chief technical features are: (1) Metallic circuits everywhere; (2) underground air-space cables with twisted conductors on main routes; (3) distribution to subscribers' premises overhead by bronze wire (except in Glasgow where most of the distribution is underground); (4) hard-drawn low-resistance copper wire on junction routes; (5) crossing of junction routes as distinguished from revolving; (6) central battery signalling (except in Guernsey and partly in Glasgow); (7) local battery speaking as being much superior to central battery speaking; (8) systematic protection of switch-rooms and subscribers' instruments by lightning and high-voltage guards; (9) the most efficient transmitters and receivers procurable, arranged invariably as handsets; (10) ring-through between subscriber and subscriber without disturbing the exchange; (11) multiple switchboards.

The type of underground duct varies. In Glasgow, Portsmouth and Swansea iron pipes are exclusively employed; in Brighton octagonal earthenware laid in concrete and some iron pipes; in Hull earthenware socket-and-spigot with Stanford joints. In Guernsey armoured cable without ducts is exclusively employed and with complete success.

Adherence to this specification yields in practice a telephone system distinguished for silent lines, loud and clear speech, rapid switching, low percentage of faults, and general trustworthiness. As a consequence the reputation for efficiency of municipal telephone systems stands high.

The Automatic System and Its Methods.

*By H. S. DURANT.**

CRITICISM and comment on the automatic system have been at a decided discount during the past twenty-four months. Critics, known and unknown, wise and unwise, have handled it over and over, apparently in all its prospects. Some whose sympathies and hopes cling to the old and established order of things have, after strenuous efforts to ignore the irresistible advance of the new idea, made an effort to hurl the telephone world into a maelstrom of doubt and perplexity, by bringing into existence what they have styled the "Automatic Problem," and this has furnished fodder enough to chew on during the time their minds are read-

* *Sound Waves.*

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justing themselves to the changed conditions

The "Automatic Problem" as it has been presented is this: Is the automatic system, new, advanced, and radically opposed to almost all the established ideas in telephony, a system which deserves to succeed the manual system which has been evolved after thirty years of experimentation directed towards its perfection? This furnishes the basis for a long bill of objections. The substance of all these arguments is that the automatic system, being the outgrowth of a new line of thinking, and a consequent subversion of the old, requiring in its manufacture a greater number of parts, and being somewhat more costly of purchase, does not recommend itself to the operating companies. Even admitting all these arguments as to newness, addition of parts and cost, to be well founded, it is easily apparent that there would still be something more to be said which these both suggest and demand.

The application of the automatic idea to telephone practice is a result as natural as the law of gravitation. It is simply another step in a larger movement which has been directed towards the substitution of the mechanical for the human element in almost every department of industry, the underlying purpose throughout being to better the means and reduce the cost of accomplishing like results. The inherent unreliability of the human agent, high rates of employment, ever growing higher, the ever-present possibility of strikes and the multitude of difficulties which in the nature of the case characterises every association between employer and employed, demand the automatic machine and are responsible for its successful introduction.

But the idea is not new. It dates its origin back to a time almost contemporaneous with the invention of the telephone itself. Indeed the telephone was comparatively a new thing and the girl had scarcely found her place in the exchange when the idea of a mechanical operator presented itself. Years of toil and unremitting effort have been expended in the working out of this idea, and the result that is offered to the companies to-day represents the results of this effort. It represents also the results of experience secured from the actual result of exchanges, the first of which was installed as far back as the early nineties. Four years ago an automatic exchange of the multiple type, the first of the kind, was installed in New Bedford, Mass. That exchange is in operation to-day, giving service to nearly one thousand satisfied subscribers. Four years furnishes a reasonable basis for a test of such a system. Indeed, one has not to look far to find cases where central energy systems of the approved types and manufacture have been installed and discarded in periods scarcely longer. Cleveland and Columbus, Ohio, furnish notable examples. I mention these simply to show that the automatic system is not new and untried, but rather one whose history chronicles success.

The second objection mentioned, that of multiplicity of parts, has been used more persistently as a red flag than any other and serves to introduce the question of maintenance cost. It is argued that because the automatic system requires a greater number of parts than the manual, the resultant cost of maintenance will be proportionately increased, and therefore the system is impossible. The line of reasoning does not compass all the facts. There is a law of compensation which, like the law of action and reaction, always holds good, and that law makes no exception in this case. If it were granted that, since the automatic requires a greater number of parts in its make up than the manual, the cost of maintenance is correspondingly increased, it must also be granted that there is a saving in another direction, namely, operating cost, and this saving so decidedly outweighs this alleged extra cost of maintenance that the force of the argument against the automatic is lost. One ordinarily competent man at a time can look after all inherent troubles in an automatic exchange of one thousand stations. This being the case, it follows that the percentage of troubles is not large. Couple this with the further facts that all parts of the switchboard are accessible, all of them capable of easy and rapid replacement, that any switch may be altogether removed from the switchboard in twenty seconds' time and without disconnecting a single wire, so that in case of total

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disability a new one may be quickly substituted, and it will be better understood why it is no hazard to assert that the item of maintenance is a burden no more serious in the automatic than in the manual system where cords, jacks, plugs, lamps, and other parts not easily or cheaply replaced are constantly making inroads in profits.

But it remains with the operating companies to answer the question. The statement of the Citizens' Telephone Company of Grand Rapids, Michigan, showing an annual saving of over $24,000 in operating and maintenance cost as a result of the installation of the automatic system, is alone sufficient to settle the matter. More significant than this statement even is the action of this company in installing, eight months after the Grand Rapids' exchange went into service, an automatic plant of 1,000 lines in Battle Creek, Michigan.

The Home Telephone Company of Los Angeles, California, were not acting inadvisedly when they adopted the automatic system in preference to the manual at a time when their previously installed board had reached its limit and additional equipment was required to provide for increasing business.

When it is taken into consideration that in the above-mentioned cases and in fact in all cases where the automatic has been adopted, the purchases were made only after exhaustive investigation of other automatic exchanges previously installed, and that in each case the question of maintenance injected itself into the consideration, these facts acquire weight, and give ground for the statement that the cost of maintaining the automatic system is not a matter of mere conjecture.

The argument furnished by the cost of the automatic equipment is a sort of trump card played by the critics to add telling effect to the two previously mentioned. That the cost price of the automatic exceeds that of the manual is admitted. There is no chance for discussion on that score. The question then resolves itself into this: Does the excess investment entailed by the purchaser of the automatic bring returns sufficient to justify the expenditure? And by returns is meant not alone saving in operating cost and the consequent satisfaction of stockholders, but improvement in service.

I think the answer to the first of these considerations has already been suggested in the preceding paragraphs, which mentioned the statement of the Citizens' Telephone Company of Grand Rapids, Michigan, showing an annual saving of over $24,000 directly attributable to the installation of the automatic.

Passing to the consideration of the subscriber's viewpoint, I think no truer idea could be given of the value placed upon automatic service by the users than by quoting from E. B. Fisher's annual report, as Secretary of the Citizens' Telephone Company of Grand Rapids, Michigan:

"Next in importance in its effect upon the system to the installation and operation of the new automatic apparatus is the change of rates for service in the Grand Rapids Exchange, which became effective April 1, and affected the earnings of the last quarter of the fiscal year just closed. The fact that that change in rates was cheerfully accepted by the patrons of the system and that, contrary to the general expectations, there was an actual net gain for telephones ordered for service during each of the three months of the quarter, notwithstanding the higher rates charged—that net gain reached 113 telephones in the quarter—is a proof of the excellence and efficiency of the service, and a compliment to the management of the company that is highly appreciated."

The results of actual investigations have shown that more than 95 per cent. of subscribers who have had an opportunity of trying automatic service lend it their heartiest endorsement.

It is not the purpose of the writer to attempt to silence any just criticism that might be passed on the automatic, nor to answer all the arguments that have been advanced against the system, for all just criticism is rather to be desired than otherwise, but the writer has intended to present a few phases of the case not always kept in view.

IN OUR NEXT ISSUE.

An important article on "Type-printing Telegraphs" by Donald Murray, M.A.

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Telegraphy Correspondence Class.—III.

Conducted by CICERONE.

PROBABLY on account of the limited time allowed for the return of answers to the first set of questions, the number received has not been large, but what is lacking in quantity is counterbalanced for in quality. Most of the answers have been excellently rendered and the students who have entered our lists need have no fear of failing either in a departmental examination or one held under the august auspices of the City and Guilds' Institute, providing of course, that they continue to manifest the same industrious application in the solution of future questions as they have displayed so far. The problems, although comprehensive, and, to some extent, outside the beaten track, were not excessively difficult. They were, however, a little in advance of the requirements of the syllabus of the City and Guilds Institute, and far beyond the necessities of the curriculum of the telegraph commercial branch. They would, indeed, cover almost anything expected from aspirants to the telegraph engineering department.

The action of the Daniell cell, which formed the theme of the first half of the first question would appear to be very well understood, as little fault can be found with any of the descriptions submitted. "Pelmar" expresses himself succinctly and accurately thus, after enumerating the constituents of the cell: "When the circuit is made, the zinc combines with the sulphion (SO_4) in the Sulphuric acid (H_2SO_4), forming zinc sulphate ($ZnSO_4$) and liberating hydrogen (H_2). The latter enters into combination with the sulphion in the copper sulphate, forming sulphuric acid and liberating copper which is deposited on the negative plate." He then gives the action before and after contact, in chemical symbols.

Before contact $Zn + H_2SO_4$ and $CuSO_4 + Cu$.

After contact $ZnSO_4$ and $H_2SO_4 + Cu$.

This is an example of an answer that an examiner likes.

The second half of this question involves a considerably deeper investigation into the physical aspects of the Daniell cell than what is implied merely by its action. To thoroughly understand "upon what its constancy depends" one has to dip into the chemistry and the electro-chemistry of the cell. This has evidently been done by most of the competitors, but "Nipper" has produced the best result, in some respects, in the following notes: "The constancy of the Daniell cell depends on the density of the copper sulphate solution, and the amount of zinc sulphate present in the dilute sulphuric acid. As the density of the copper sulphate solution falls, the e.m.f. of the cell falls. It also falls because the sulphate of zinc formed in the *porous cell* is dissolved in the dilute sulphuric acid. The density of the copper sulphate solution can be maintained by having crystals of the sulphate placed in the liquid to keep it saturated, but the sulphate of zinc cannot readily be withdrawn from the dilute sulphuric acid. Therefore to keep the e.m.f. constant it is best to start with both solutions saturated. The resistance of the cell will be higher and its e.m.f. lower than when dilute sulphuric acid is used, but this lower value will be maintained constant while the cell is sending a current."

The fault of this answer is that it is rather lengthy. It shows, however, a good knowledge of the subject, and it is in the main correct. He should not refer to the zinc-containing compartment as the porous cell, as the porous pot is as frequently used for containing the copper as it is for the zinc.

"Treyar's" answer is incomplete, but it adds a little to what has been omitted by "Nipper." Treyar says the constancy depends "in a lesser degree on the amalgamation of the zinc rod, which prevents local action. Principally the constancy is due to the depolarising fluid, copper sulphate, in which the copper plate is placed. The liberated hydrogen, by means of this depolariser, is got rid of in its free state as quickly as it is evolved from the outer jar."

Briefly, the question might have been answered: "The constancy of a Daniell cell depends, not only upon the absence of local action, and the freedom from polarisation—characteristics common to other types of cells whose e.m.f. and resistance are not constant—but also to the action, peculiar to the Daniell, by which the density of the liquids is maintained sensibly constant for a long time." The zinc sulphate increases and the copper sulphate diminishes its density in the same ratio. The addition of bluestone crystals to the copper sulphate solution keeps it uniformly saturated, and it is only necessary to withdraw some liquid from the zinc sulphate solution and add water in order to maintain its constancy. Theoretically, then, the sulphuric acid should remain in a constant state if the other ingredients are kept up to proper standard.

The highest e.m.f. is obtained when the copper sulphate solution is supersaturated, and before any quantity of zinc sulphate has been formed. This is, as "Nipper" points out, not its most constant state however.

The best conductivity is obtained when 30 per cent. of sulphuric acid is added to water, but this strength produces an unnecessary waste of zinc, and the solution need not contain for practical purposes more than one part of acid to twelve of water.

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The second question has also been very well answered by " Pelmar," as follows :

" Chemical osmotic action consists of a slow interchange or diffusion of two liquids separated by a porous partition, the tendency being for the liquid possessing the higher specific gravity to pass through the partition, and mix with the other liquid. Electrical endosmose is the effect produced by the ' carrying ' as it may be called, of particles of the solution in the cell containing the positive plate through the partition into the liquid surrounding the negative plate. Broadly speaking, the difference between the two actions is that chemical osmose in a cell goes on irrespective of the direction of the current, whilst electrical endosmose is always in the direction of the current through the cell."

It is owing to osmotic action in the Daniell cell that the pure copper, known by the battery-man as black mud, finds its way from the copper to the zinc compartment. The density of copper sulphate being greater than that of zinc sulphate, tends to carry some of the former through the porous partition into the zinc compartment, where the pure copper is deposited in the form of fine black powder. Electrical endosmose, on the other hand, tends to counteract this effect, because when a current flows, the pure copper from the copper sulphate solution is conveyed by the current through the liquid in the opposite direction and deposited on the copper plate. Hence the Daniell cell is better adapted for constant than for intermittent working.

The osmotic action may be somewhat reduced by keeping the liquid in the zinc compartment at a higher level than that in the copper compartment.

Electrical endosmose is sometimes called cataphoric action, and many pretty experiments have been tried to show its effects. One peculiar feature is that the liquid in a cell rises in the compartment by which the current leaves the cell, and Lord Armstrong has shown an experiment by which a piece of thread was drawn over the partition which separated the two compartments, by means of the current. In chemistry, endosmose is referred to as the passage of a fluid *inwards*, and exosmose as the passage of the fluid *outwards*, through the separating membrane.

" Local action is caused by the impurities of ordinary commercial zinc, particles of carbon, lead, tin, &c., becoming embedded in course of manufacture. A difference of potential exists between the zinc plate, and these particles of dissimilar metal, and minute currents are set up when the cell should be at rest. It may be prevented by applying mercury to the surface of the plate by means of a piece of flannel, after first cleaning it in an acid. By this means a paste is formed or an amalgam of mercury and zinc, the foreign particles being covered up and only the amalgamated surface coming into contact with the exciting fluid." Such is the answer of " Vectis " to the question, " What is meant by local action and how can it be prevented." It can also be prevented by using pure zinc, a much more expensive method than amalgamation, however. A better amalgam is formed by adding a certain percentage of mercury to the molten zinc before it is cast into plates, than by simply rubbing the surface of the plates.

There are two theories advanced regarding the action of amalgamated zinc : the one accounting for the prevention of local currents by the amalgam mechanically covering up the impurities on the surface of the zinc, and preventing them coming into contact with the liquid ; and the other holding that the zinc is prevented from local action by the formation of a film of hydrogen gas on the surface of the plate. Neither theory is accepted as a complete settlement of the question, but certain it is that amalgamated zinc acts somewhat more positive than pure zinc, and therefore gives to a cell a slightly higher voltage than that of a similar cell having an unamalgamated plate.

The following is an example of a very common error, found in fact in several text-books. " Galvanic polarisation is the setting up of a backward e.m.f. by the accumulation of hydrogen on the negative plate of a cell—*hydrogen being electro-positive to zin* ." Hydrogen is *not* electro-positive to zinc, and it is more accurate to say that the potential difference between zinc and hydrogen is less than that between zinc and copper (or whatever elements are being used) than that there is a counter e.m.f. set up. The electrical pressure of zinc in a sulphating medium is 3.16 volts and that of copper in the same medium is 2.07 volts, or a resulant e.m.f. of 3.16 − 2.07 = 1.09 volt, which is the voltage of a Daniell cell. When the copper plate becomes covered with hydrogen the resultant e.m.f. becomes : pressure due to zinc = 3.16 volts, pressure due to hydrogen = 2.34 volts. Difference, 3.16 − 2.34 = 0.82 volts, which accounts for the diminution in the effective e.m.f. after polarisation has taken place. The current is enfeebled still more, as the resistance of hydrogen is far greater than that of pure copper.

A typical answer to the second half of this question is, " Polarisation may be prevented by brushing the hydrogen off the plate, or by producing small points on the surface of the plate on which the hydrogen accumulates and rises therefrom in bubbles to the surface of the liquid in the cell. The usual method of preventing polarisation is to place the positive and

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negative plates in separate compartments with a porous partition between them. The compartment containing the positive plate also contains the exciting solution, whilst with the negative plate is placed a solution chemically prepared in such a way that the hydrogen liberated by the action of the excitant is combined to form a compound which is not deleterious to the working of the cell, and is not allowed to reach the negative plate at all. In the Daniell, Leclanché, and bichromate cells the depolarising agents are copper sulphate, manganese dioxide, and bichromate of potassium respectively." Briefly, there are various mechanical, chemical, and electro-chemical methods of preventing polarisation, but the electro-chemical is most effective and reliable.

" The merits of the Daniell are constancy of e.m.f. and resistance, moderate cheapness in construction and maintenance. Demerits : e.m.f. comparatively low. Osmotic action which takes place results in wastage of material when battery not worked, and to minimise this effect thicker porous partitions are used which increase its resistance. Leclanché.—Merits : Fairly high e.m.f. and low resistance, no wasteful action when cell at rest, and consequently requires attention less frequently. Cheap in construction and maintenance. Demerits : The use of the solid depolariser manganese dioxide is not conducive to rapid oxidisation, therefore the cell polarises if used for constant heavy currents.

" Bichromate.—Merits : High e.m.f. and low resistance. Inexpensive to instal and maintain. Best adapted for heavy current working. Demerits : Depolarisation not quite rapid enough, therefore output not so constant as the Daniell if worked continuously. Not suitable for a standard, or for testing purposes."

To this question some excellent answers were received, but the above gives the salient points in brief. " Treyer " says he has not gone in for telephony, but we shall lead him up to that subject by and by. For most telephonic purposes the Leclanché is the most suitable cell, and in the agglomerate form it acts well on long telegraph circuits, its e.m.f. being fairly high and resistance extremely low.

Answers to the next question were, in several cases, somewhat mixed. The following gives the definitions implied, very briefly:

" E.M.F. depends upon the nature of the elements employed in the cell, the number of cells joined in series, and to some extent upon the exciting and the depolarising agents. The term e.m.f. is usually applied to the total e.m.f. of a particular circuit ; the potential difference to the electrical pressure between any two points in a circuit, the latter depending upon the resistance and the current between the two points. Resistance depends upon the nature and the size of the plates, their distance apart, and upon the nature and quantity of the other constituents contained in the cell. If cells are joined in series their total resistance will be the sum of their separate resistances, but if joined in parallel their resistance is only equal to that of one cell divided by the number of cells. Current depends directly upon the e.m.f. applied, and is in inverse proportion to the resistance offered by the conducting path of the circuit."

" Vectis " answers the next question regarding a standard cell as follows :

" Obtain a short, wide test-tube and fuse into the bottom a platinum wire so that it projects inside tube, place in the bottom a layer of pure distilled mercury, which forms the negative element, to the depth of about half an inch, and on top of this a mixture composed of mercurous sulphate and zinc sulphate. The positive element, a zinc rod, is then inserted in the paste and the top of tube is sealed with marine glue. It is essential that the materials used should be pure. Care must be taken, with a view to ensure the uniformity of the electro-motive force, that it should not be short-circuited or used with a low external resistance. Thus constructed it is known as the Latimer Clark standard cell."

" Changes of temperature affect the electro-motive force and internal resistance of primary cells. During cold weather there is a diminution of electro-motive force, and an increased internal resistance. With a rising temperature the electro-motive force increases and internal resistance diminishes."

Several competitors have described the Daniell standard cell, but the majority favour some form of the Clark. A number have fallen into the error of saying that e.m.f. is independent of temperature, notwithstanding the fact that the e.m.f. of the Clark standard cell is always quoted at a certain temperature, and that it varies its e.m.f. with changes of temperature. In fact, every cell has a certain temperature coefficient which affects its e.m.f. One student says, " The general effect of raising the temperature of a primary cell is to increase its output. This is a result of a decrease in the internal resistance due to the fact that the chemical compounds are rendered more unstable, and therefore separate more readily when heated."

The e.m.f. of a Clark standard cell at 15° C. is 1.434 volts, and it rises or falls .077 per cent. as the temperature rises or falls 1° C.

A typical answer to the final question is appended. It is, if anything, too long, and several parts might have been omitted

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without detracting from the value of the description.

"The electric power storage cell is that in general use in the post office. Seven plates or grids are employed four of which are negative and three positive. The positive plates are comparatively thick and grooved so that a large quantity of paste composed of minimum and dilute sulphuric acid can be worked into the grooves. The negative plates have holes in them with projections across to keep the paste with which they are 'formed' (as the process of pasting the grids is called) in position. Letharge is added to the minimum and sulphuric acid with which the negative plates are formed. The excess number of negative over positive plates is to ensure that chemical action takes place on both sides of the positive plates. The plates or grids are constructed of lead alloyed with 10 per cent. of antimony to prevent the chemical action of the electrolyte upon them and to mechanically strengthen them. The positive and negative plates are arranged alternately, the three former being connected at the top and the four latter at the bottom, this method of joining ensures equality of chemical action. The plates are placed quite close to each other, sufficient space only between each being allowed for the dropping clear of any particles of the pastes which may become detached. The containing vessel is of glass and thus enables a close examination of the cell to be made. The electrolyte or fluid which the action of the primary current decomposes in the action of charging is sulphuric acid. During charging the positive plate and pole of the secondary cell are in connection with the positive pole of the dynamo, by means of which the cell is charged, and the negative plate and pole in connection with the negative pole of the dynamo. The effect of 'charging' reduces the 'former' upon the negative plate to spongy lead and that upon the positive plate to lead peroxide. In discharging, *i.e.*, when the secondary cell is being worked the actual conditions of the plates are reversed. The poles, however, are unaltered as the current flows from the positive to the negative pole."

"Secondary cells or accumulators are specially adapted for the universal battery system of telegraphy on account of their exceedingly low internal resistance and constant electro-motive force. They are equally adapted for the working of long trunk telephone circuits for like reasons."

A fuller and more comprehensive reply to the second half of this question is given below.

"Secondary cells are very useful, where facilities for charging these exist, for the working of a number of telegraph circuits or a telephone exchange on the common battery system. The e.m.f. (about two volts) is fairly constant if not allowed to fully discharge whilst the internal resistance is almost negligible. The disadvantages attending their use are mainly the need for some facilities for charging them, which, of course, is not required in primary batteries, and the careful and constant attention necessary to keep them in good condition. Where the number of circuits in use justifies the provision of, or employment of existing, power for charging and the maintenance of staff to supervise them their advantages over primary cells are almost incalculable."

The next set of questions will deal with the conductor. The chief properties of the conductor are resistance, and electrostatic capacity, but in the case of an iron conductor there is another property due to the magnetic effect inherent in the iron itself, or to its being magnetised longitudinally by the electric current. To this electro-magnetic phase has been given the name of electro-magnetic inertia, and its effect is to retard the speed of the current. As the current flows, it magnetises the iron, which then acts as an inertia, or tends to remain in whatever condition it may be placed. If magnetised it is slow to become demagnetised and when demagnetised slow to become magnetised again, and so on. This effect naturally absorbs some energy, and acts as a retardation. Its value is not easily measured, but it is so troublesome that iron wire has now become entirely out of use for high-speed telegraphy and for long-distance telephony.

The resistance of a conductor depends upon the nature of the material of which it is composed, its length, its sectional area, and its temperature.

Every material has a certain specific resistance or resistivity, resistivity being the converse of conductance. Some materials conduct better than others, but there is no perfect insulator or non-conductor. The best conductors are such pure metals as silver and copper, both having about the same specific resistance, but the latter at much less cost. Copper conducts about seven times better than the best Swedish charcoal iron. That is to say, that the specific resistance of copper is only one-seventh that of iron. The specific resistance of a material is the resistance of one centimetre cube of the material; that is one centimetre in length by one square centimetre of sectional area. To the class of insulators or non-conductors belong porcelain, dry air, dry paper, silk, mica, glass, wax, ebonite, gutta-percha, india-rubber, &c. For this reason these substances are usually selected for insulating purposes, the quantity of current getting through any of them even with a

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very powerful electrical pressure being extremely small. On the other hand, for conducting large currents metal conductors of large sectional area are selected. Bronze has been tried, but it is only suitable for short lines, its chief advantage being great tensile strength. No alloy conducts so well as either of the metals of which it is composed, so they are only employed when very high resistances are required in little bulk.

The standard ohm, or unit of resistance, is the resistance of a column of pure mercury 106.3 centimetres long, of uniform cross-section, and weighing 14.4521 grammes at 0° C. At this weight the sectional area is about one square millimetre, but as it is somewhat difficult to get a glass tube to form a column of absolutely uniform bore, it is preferable to quote the weight. With this standard, others constructed in metals can be compared from time to time just as is done with standards of weights and measures.

The specific resistance of materials is usually given in microhms or millionths of an ohm, while the resistance of insulating bodies is quoted in megohms or millions of ohms, so great is the range in the field of electrical resistance.

Silver and copper have each a resistance per cubic centimetre of 1.634 microhms, platinum, and iron have each a little over 9 microhms, while platinoid has 34 and mercury 94.3 microhms.

Having obtained the value of the specific resistance S of any material the resistance R of any quantity of that material may be found. $R = S\frac{l}{a}$

l being the length and a the sectional area.

Resistance also varies with temperature, every material having a certain temperature coefficient, or percentage of increase or decrease per degree Centigrade. Metals and all good conductors increase resistance with increase of temperature, liquids and insulators lower resistance with increase of temperature.

$$Rt = Ro\,(1 + Kt)$$

where Rt = resistance of body at particular temperature.

Ro = resistance of body at 0° C.

t = the actual temperature of the body

K = the increase per degree Centigrade, temperature coefficient.

The percentage increase per degree Centigrade for copper is .00388, that for platinoid .00022.

It is sometimes convenient to know the resistance per cubic inch, instead of cubic centimetre, since our measurements are mostly given in inches, feet, or yards.

Copper has a resistance of .6433 microhms, and iron 3.825 microhms per cubic inch.

If a conductor is made up of several sections in series, the total resistance will be the sum of the resistance of the separate sections, but if several conductors are joined in parallel their joint resistance will be the reciprocal of the sum of the reciprocals of all the conductors. If two conductors be joined in parallel their joint resistance will be equal to the product divided by the sum of the two separate resistances.

There are two methods of measuring wire, one by its diameter, the other circular. The diameter may be measured in millimetres or in mils, but as it is the area generally that is wanted and not the diameter this plan is not the best. In America they use the circular mil which is a measure of area. The advantage in using mils (*i.e.*, thousandths of an inch) is that whole numbers may be obtained instead of fractions.

[NOTE.—1 inch = 25.4 millimetres and 1 millimetre = 40 mils nearly.]

(Students should read Editorial note on page 333.)

EXERCISE III.—APRIL 1905.

1. (*a*) What is the resistance of a copper wire 250 miles in length and 165 mils in diameter?

(*b*) By how much would its resistance be altered if the temperature rose from 0° to 20° Centigrade ?

2. (*a*) Two wires of 5 ohms each—one from each pole of a dynamo—are connected to ten lamps of 150 ohms each in parallel. What is the total resistance ?

(*b*) What current does each lamp get from 100 volts on the terminals of the dynamo ?

3. (*a*) Of 30 amperes how many flow through each of two wires in multiple, one having a length of 24 ft. and a weight of 5 oz., and the other a length of 12 yards and a weight of 2.5 oz. ?

(*b*) Find the length of a copper wire whose resistance is 50 ohms and weight 75 cwt.

4. (*a*) What materals are best suited for the construction of resistance coils and for telegraph and telephone lines ?

(*b*) What length of wire is required to fill a bobbin 2 in. long and of 2 in. outer and 1 in. inner diameter ?

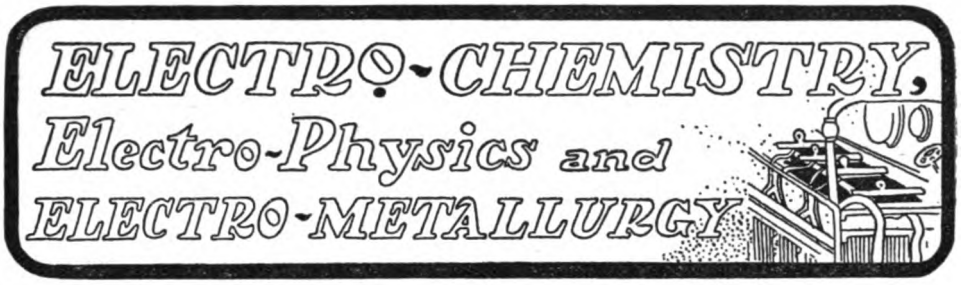
5. (*a*) State the relationship between weight, length, diameter, and resistance of a wire.

(*b*) If 25 miles of wire weighing 8,000 lbs. have a resistance of 100 ohms, what is the resistance of 200 miles of the same material the weight of which is 20 tons ?

6. (*a*) What is the specific resistance of a material a wire of which 250 kilometres long and diameter of 50 millimetres has a resistance of 2,000 ohms ?

(*b*) What diameter of copper wire (measured in mils) has a resistance of 5 ohms per mile ?

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Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

The Electrolytic Preparation and Production of Calcium, Strontium, and Barium.

(Special Article.)

By F. MOLLWO PERKIN, Ph.D.

ALMOST 100 years ago, after his discovery of the metals sodium and potassium, Sir Humphrey Davy turned his attention to the isolation of calcium. He was unable to isolate it by the same methods which had proved so successful in dealing with the alkali metals. He succeeded, however, in obtaining an amalgam of calcium by electrolysing calcium chloride with a mercury cathode. By distilling off the mercury small quantities of metallic calcium were obtained. Bunsen succeeded in obtaining several grams of metallic calcium by electrolysing calcium chloride which had been moistened with hydrochloric acid. Matthieson about the same time obtained it by electrolysing a fused mixture of calcium and sodium chlorides. Recently Moissan obtained it in rather larger quantities by electrolysing fused calcium iodide, at a low red heat, not, however, on a technical scale. Moissan employed a nickel cathode and a graphite anode. The metal was obtained in small globules and had a purity of 99 per cent. He also obtained it chemically by the action of metallic sodium on calcium iodide $2Na + CaI_2 = Ca + 2\,NaI$. An excess of sodium was used and an amalgam of calcium and sodium produced. The sodium can be separated from the calcium by the action of absolute alcohol, which dissolves the sodium but has very little action upon the calcium. The difficulty experienced in all the electrical methods so far described was to remove the metallic calcium from the fused electrolyte, as there was a tendency for it to diffuse itself throughout the fused salt and to react with it. According to Bunsen the conditions necessary for obtaining the metal are (1) high current density, (2) high cathode temperature, (3) low temperature of the electrolyte, because if the temperature of the electrolyte is below that necessary to melt the metallic calcium, there is less tendency for interaction between the fused salt and the metal to take place.

In 1902 Borscher described a process for arriving at the above results. Calcium chloride was used as the electrolyte and was kept at a temperature just a little above its melting point, which is only about 40–50° C. below the melting point

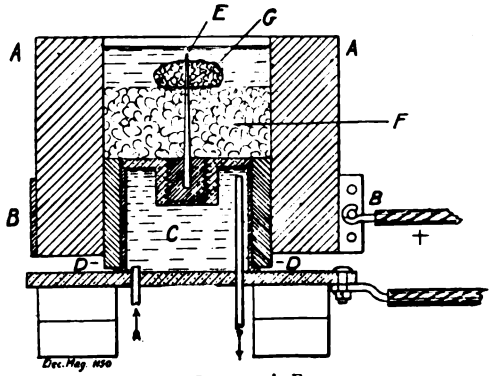


FIG. 1.—BORSCHER'S FURNACE.

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of calcium. Fig. 1 illustrates the form of furnace employed by Borscher. It consists of a circular cylinder of graphite AA, made from pieces of graphite held together by an iron ring BB to which the leads from the positive source of current are connected. The bottom of the furnace is made of a metal water bath C, through which cold water can be circulated. It is insulated from the graphite sides of the anode by the insulating material DD. In the centre of this vessel an iron rod E is fixed which acts as cathode, the negative current being conveyed through the metal bath. The bottom of the furnace is covered with powdered fluor spar F, and the upper portion with anhydrous calcium chloride. From the construction of the furnace it is seen that while the cathode surface is small, the anode surface is relatively very large.

In commencing the operation thin spars of carbon are fixed across from the anode to the cathode, and lie along the top of the calcium chloride. When the current is passed these become very hot, and thus fuse the calcium chloride. As soon as the salt is thoroughly fused the carbon spars are removed as rapidly as possible and the actual electrolysis commences, the current now being conveyed through the molten electrolyte.

As the calcium separates out it forms a spongy mass G round the cathode, the temperature of the molten electrolyte not being sufficiently high to fuse it. This sponge, on being removed by a pair of iron tongs and immediately placed under rock oil or other oil free from oxygen, was found to contain a very large quantity of calcium chloride, held in the interstices of the metal. The amount of metal varying in different experiments between 50 and 60 per cent. By using flat tongs, previously heated, and squeezing the metal between them, immediately on removing it from the bath, calcium of 90 per cent. purity could be obtained.

In the same year Plato and Ruff published a method for obtaining metallic calcium from a fused mixture of 100 parts calcium chloride and 16.5 parts of fluor spar; the melting point of this mixture is 660°, that of calcium chloride 780°. They melted the mixture in a porcelain or carbon crucible and electrolysed, with a large carbon anode and a 2-millimeter thick iron cathode. Owing to the heavy current employed the cathode kept at a low red heat during the operation. The metallic calcium formed a globule on the end of the cathode and from time to time was shaken off, when it floated on the surface of the molten electrolyte, from which it was readily removed by means of a piece of iron wire. Plato and Ruff found that it does not do to have the temperature of the electrolyte much above 800°, because if it is, an alloy of iron and calcium is produced. Arndt also published a somewhat similar method. It will be noticed that the chief difference between the methods of Borscher, Plato and Ruff, and Arndt, is that in the first case the calcium chloride is electrolysed at a temperature below the fusing point of metallic calcium, whereas in the second case the metal is obtained in the fused condition.* Further, in the one case the metal is produced below the electrolyte and in the other at its surface. It has already been mentioned that there is a tendency for the metallic calcium to unite with the electrolyte to produce calcium sub-chloride $CaCl$. Borscher considers this is less likely to happen at low temperatures, whereas Plato and Ruff think its formation is prevented by a high current density.

Now the methods so far described have not been found to give satisfactory results on a technical scale. We come now to a method which is a slight modification of that of Plato and Ruff, and by which means calcium is readily obtained on a manufacturing scale at a comparatively low price. The process reminds one of the method used by Rathenau and Suter for the electrolytic production of sodium from sodium hydrate. The sodium hydrate is fused and the cathodes simply touch the surface of the fused electrolyte, the sodium forming on the end of the cathode just below the surface of the electrode. Indeed the new process for preparing calcium is probably taken from the experience gained in manufacturing sodium, because it has been worked out by Rathenau and Suter. Fig. 2 gives

* In the process of Plato and Ruff, although the electrolyte material fuses at a lower temperature than in the method of Borscher, the cathode temperature is higher.

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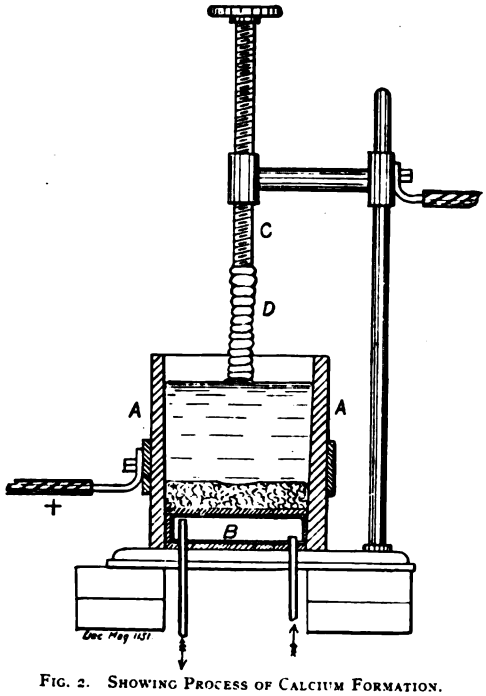


FIG. 2. SHOWING PROCESS OF CALCIUM FORMATION.

an idea of the method. AA is a graphite cylindrical vessel for containing the fused electrolyte, which has a metal bottom B, insulated from the carbon sides; this bottom is really a water jacket through which cold water is circulated. In this apparatus either a mixture of calcium chloride and fluoride may be employed, or pure calcium chloride can be used. In the illustration a layer of calcium fluoride is shown at the bottom of the fused calcium chloride. The cathode C is of iron, and can be raised or lowered at will. The calcium chloride can either be fused before being placed in the electrolysing bath, or can be melted by the method employed by Borscher and described at the beginning of this article. As soon as the electrolysis commences, a layer of calcium forms at the end of the iron cathode, which is then slightly raised; this process is repeated so that a rod of calcium somewhat resembling the rod D shown in Fig. 2 is produced. In Fig. 3 a photograph of a rod of metallic calcium 19 cm. long and 3.5 cm. in diameter, weighing 330 gms., is shown. This rod was obtained from the Electrochemische Werke, Bitterfeld. On a manufacturing scale, the operation of screwing up the cathode as the calcium is formed would be a tedious process, so that I believe—although I have no absolute information—that an electro-magnetic arrangement is employed. Less than one year ago metallic calcium was quoted at 5*s.* per gram or £250 per kilogram; to-day it can be obtained in 100 kilogram lots at 12*s.* per kilogram or in kilogram quantities at about 21*s.* In the United Kingdom it costs from 27*s.* to 30*s.* per kilogram. A rather interesting point cropped up with reference to the importation of metallic calcium into this country. A short time ago I ordered one kilogram of the metal from Germany. The calcium arrived, packed in hermetically sealed tins, without any difficulty at Hamburg, then the trouble began. The shipping company wanted to know a great deal about it—would it explode, what happened if it came in contact with water, did it contain low flash naphtha, &c.? Finally the shippers absolutely refused to take it—*but it did arrive.* A little technical education would do some of the heads of the shipping companies good. After all

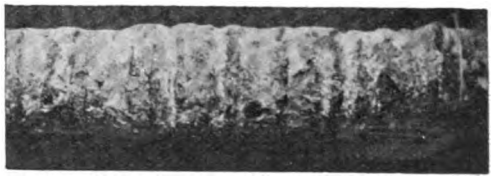


FIG. 3. ROD OF METALLIC CALCIUM.

in this country it is more the heads than the employees in large business concerns who require educating.

PROPERTIES OF CALCIUM.

When freshly cut the clean surface of calcium has very much the appearance of metallic zinc, but it very rapidly tarnishes in the air, assuming first a yellowish brassy appearance and then becoming grey or white from a superficial coating of calcium hydrate. When exposed to the air for some time the whole surface becomes moist from the action of the moisture of the air. The moist metal generally has a slight smell of acetylene, probably from the presence of a trace of calcium carbide produced from the carbon anodes. If the clean metal is placed in

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water at first a vigorous action is set up, due to the decomposition of the water; the action becomes less after a short time, owing to the formation of calcium hydrate, but in presence of dilute hydrochloric acid which dissolves the coating, the action is exceedingly vigorous. It is only very slowly acted upon by alcohol, which is in strong contrast to the action of alcohol upon the metals sodium and potassium. Calcium is nearly as hard as aluminium, but softer than zinc or magnesium. Its tensile strength is about 8,710 lb. per square inch. The metal can be easily turned in the lathe, but is rather inclined to clog the tools, especially when being drilled. Compared with wires of equal diameter and length, calcium is the fifth best conductor of electricity, but for wires of equal weight and length it stands second. There is some diversity of opinion as to the actual melting point of the metal, various investigators giving it as being between 760 and 800° C. It combines not only with oxygen to form calcium oxide, but also readily with nitrogen on heating to produce calcium nitride Ca_3N_2. Owing to this fact it can be used to produce an almost absolute vacuum. If a piece of metallic calcium is placed in a partial vacuum and then heated, it unites both with the oxygen and nitrogen so that a practically perfect vacuum is produced.

Metallic calcium is placed on the market in rods, such as that shown in Fig. 3. It can be used in place of magnesium or aluminium to deoxidise iron and steel, or for other metallurgical purposes where a strong reducing agent is required. Not only does it remove oxygen but it also takes up any occluded nitrogen which may be present.

Probably because calcium is the lowest member of the series of the alkaline earth metals, and is found in such abundance and so very widely distributed in nature, more attempts have been made to manufacture it than to prepare the similar metals strontium and barium. But from what I as already been said it will be seen that it has taken nearly 100 years to arrive at a satisfactory process for its production.

Borscher and Stockem have also succeeded in obtaining metallic strontium by using an apparatus which is depicted in Fig. 4.

The apparatus, it will be noticed, is

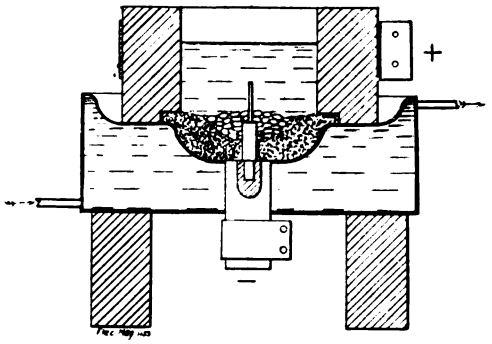


FIG. 4. APPARATUS FOR PRODUCING METALLIC STRONTIUM.

much the same as that employed by Borscher for preparing calcium. It was found, however, that when the calcium apparatus was employed the metallic strontium was obtained in the form of molten globules, the specific gravity of which was less than that of the molten electrolyte; consequently the metallic globules rose to the surface and were carried to the neighbourhood of the anode, where they recombined again with the chlorine and a portion united with the fluid strontium chloride to form strontium sub-chloride $SrCl$. As can be seen from the figure, which explains itself, the change in the apparatus chiefly consists of a greater cooling surface at the bottom of the electrolysing vessel, and fire clay is tamped down so as to form a hollow bed; further, the end of the cathode only is exposed. The strontium, therefore, as it is, falls molten from the cathode, becomes almost immediately cooled and sinks to the bottom of the hollow surrounding the cathode. After the electrolysis has been stopped and the fused strontium chloride has solidified, it is broken up, when the strontium is found in large globules embedded in the strontium chloride, some of the globules measuring as much as 10 mm. (0.4 in.) across.

Metallic strontium has much the same appearance as calcium, being white like zinc and about as soft as lead.

No really successful process has as yet been devised for preparing metallic barium, although Davy obtained it in the form of an amalgam by electrolysing a strong solution of the chloride with a mercury cathode. As a matter of fact this method is the only one, so far as I am aware, which up to the present time has given at

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all satisfactory results. Guntz prepared such an amalgam and distilled off the bulk of the mercury at a temperature of 600–850°, the last portions at a temperature of 1000° C. Barium so obtained is as soft as lead, melts at about 850° and vaporises at 1150°. From experiments which I have myself undertaken in another direction, barium appears to be more readily oxidised and more readily inflammable than either calcium or strontium.

The Measurement of High Temperatures.

By L. RAMAKERS.

WITHIN the last few years the demand for appliances for pyrometric measurements has increased in a marked degree, as all those industries using high temperatures in connection with the manufacture or preparation of their products have recognised the great value of being able at any moment to determine the extent and value of the temperatures obtained. The introduction of pyrometers fitted with registering devices was also rendered imperative by another consideration, especially in cases where foundries are concerned. In order to work blast furnaces in a proper manner it is of the most vital importance that the hot air, which is pre-heated in the Cowper apparatus and then forced through the furnaces by means of blast devices, should be of a temperature which never falls below a certain level. As work is continued night and day without interruption, it is, of course, not possible to exercise a continual supervision. By means of this method of uninterrupted registration of the temperatures, the person entrusted with the supervision of the work has at his disposal a priceless aid in controlling the duties of the workmen; in this way all irregularities are permanently avoided.

Fig. 1 shows the recorder for a plant of tempering furnaces, the temperature of which is controlled by means of two thermo-electric couples with a galvanometer. These thermo-electric couples, which consist of two wires of platinum or of an alloy of 90 per cent. platinum and 10 per cent. rhodium, are contained in guard pipes projecting from the top of the furnaces. The connecting wires of the two elements or "couples" lead to a bi-polar change-over switch, which enables either the one or the other of the elements to be connected direct to the measuring device indicating the temperature of the furnace. This latter is mounted upon a small wall bracket (Fig. 1) in such a way as to be as free from all vibration. In view of the exacting requirements now made in connection with the quality of steel for the manufacture of tools, it is absolutely essential that practically individual attention should be given to different kinds of steel, and more especially so during the tempering process; it has also been found that the practice of estimating the temperature for tempering by the aid of the eye, is by no means sufficient to enable a uniform product to be obtained. With the aid of a pyrometer it becomes possible to maintain absolutely constant (up to within a few degrees) the temperature of a modern gas fired tempering furnace.

Figs. 2 and 3 show a plant for measuring the temperatures prevailing in the hot air conduits of blast furnaces. The duties

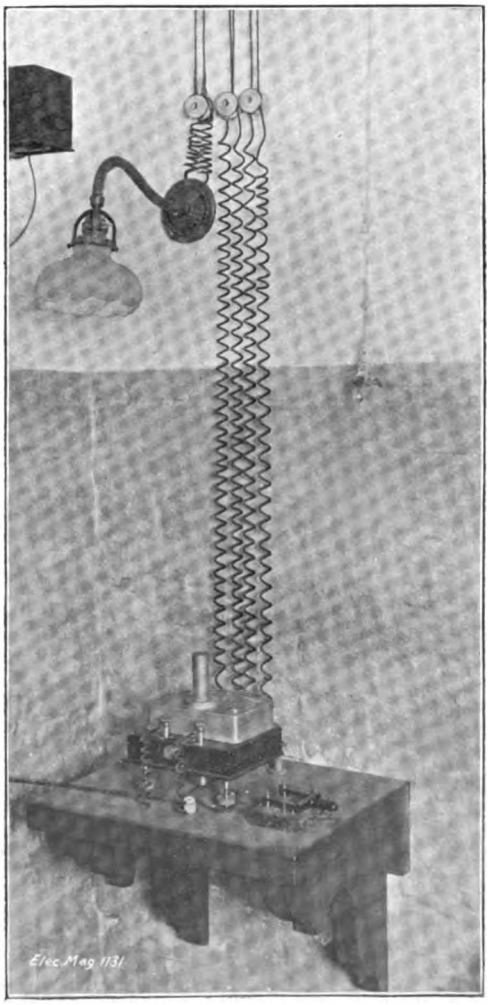


FIG. 1. GALVANOMETER FOR INDICATING TEMPERATURE OF TEMPERING FURNACES.

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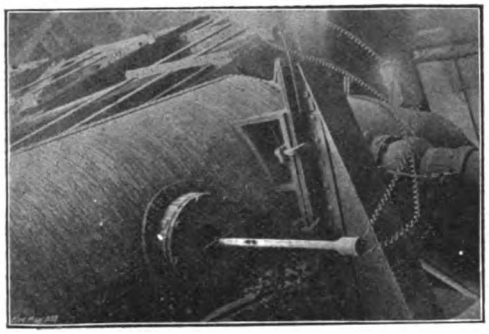


FIG. 2. ARMOURED THERMO ELEMENT IN BLAST FURNACE HOT AIR CONDUIT.

which these devices have to fulfil are as follows: Each blast furnace has two so-called Cowper apparatus, one of which is traversed by the hot gases, &c., coming from the blast furnace whereby it is heated, whilst the other has the cold air drawn in from outside driven through it by means of blast engines, and in this way the said cold air is heated up to a temperature of from 700° to 900° Centigrade. Now, if the temperature of the latter apparatus, and consequently that of the air also, has fallen to a predetermined extent, then the cycle of operations is reversed: that is to say, the first mentioned freshly heated apparatus is used for heating the air, and the latter is again heated afresh. In order to make an observation of this process there is located in the hot air conduit of each of the blast furnaces, which are arranged in a circle round it, a thermo-element placed in a protecting tube; from the free ends of this thermo-element a naked wire, placed upon insulators, leads to the common point of location of the corresponding registering element, after first traversing a lightning conductor arrangement with a coarse and fine fuse so as to protect the instruments against atmospheric discharges or any adjacent high-tension wires. The arrangement is such that it can be seen at a glance, and it enables the working of each air conduit to be controlled from this point. Every fluctuation in temperature is at once made apparent in the diagram, so that the official entrusted with the supervision is at once in a position to see any irregularities that may arise—irregularities which may lead to serious consequences in this class of work if neglected.

At all points where the instruments, which always require attention, cannot very well be placed in an exposed condition—either because the air is filled with dust or harmful vapours, or for any other reason—they are preferably built into an hermetically sealed box (Fig. 3) which contains also, besides the instrument, a roller capable of being operated from the outside for winding up the strip of paper which has been unrolled. Lateral openings are also provided for attending to the clockwork, and it is quite unnecessary to open the box except to renew the paper which has to be done about four times every year. In the lid there are two glass windows to facilitate readings being taken of the scale and the strip of paper that has become unwound.

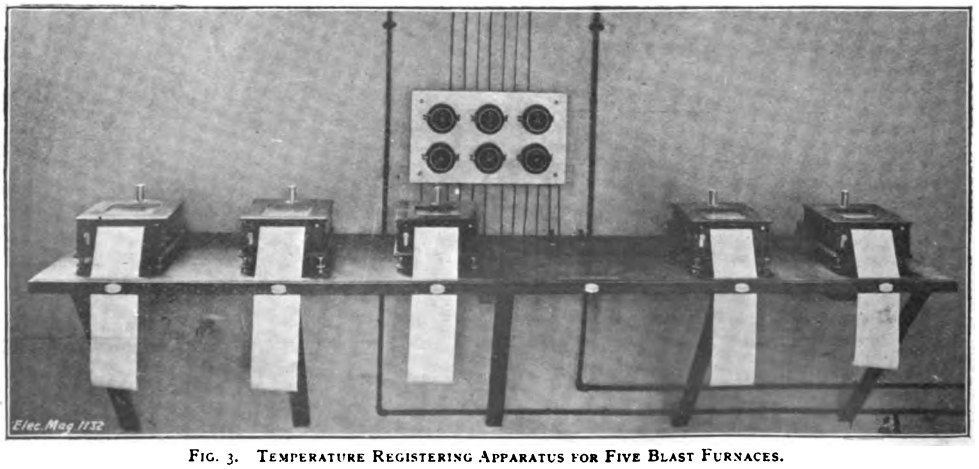


FIG. 3. TEMPERATURE REGISTERING APPARATUS FOR FIVE BLAST FURNACES.

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A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section at end of Magazine.

MANUFACTURING ENTERPRISE OF THE GENERAL ELECTRIC CO., LIMITED, AT WITTON WORKS, BIRMINGHAM.

By OUR SPECIAL COMMISSIONER.



THE General Electric Company, Limited, of Great Britain, despite the similarity of its name to that of American and Continental firms, has remained distinctive for many years now in electrical manufactures, and preserved an individuality which has always been impressed upon the various stages of its development. Although it is our intention within the narrow compass of this article to record the enterprise of this company at its large works at Witton, Birmingham, we must remind our readers that other and older extensive undertakings are in active operation at Peel Works, Manchester, Sherlock Street, Birmingham, Union Street, Southwark, and Brook Green, Hammersmith. At all of these some 5,000 hands are employed in the manufacture of switchboards and switchgear for lighting and power, feeder pillars, measuring instruments, telephones and telegraph apparatus, bells, signalling systems, electric light fittings, arc lamps, and incandescent lamps, &c. &c., representing a branch of manufacture of which the company is justly proud. In the year 1900 it was decided to acquire a site of land near Birmingham on which to build large works for the manufacture of electrical machinery up to any size, and no expense has been spared to instal the best class of tools available for the purpose. At the same time, with that characteristic enterprise for which the management has



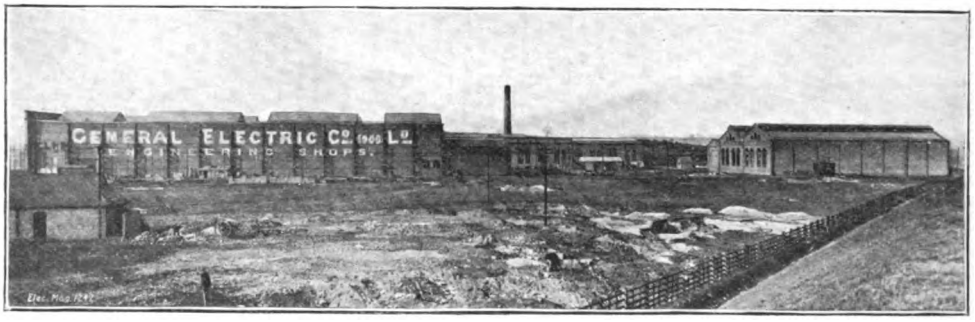
Carbon Works. *Power House.* *Engineering Shops.* *Conduit Works.*

EXTERIOR OF WITTON WORKS.

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always been distinguished, the erection of carbon works was decided upon and fearlessly carried through in spite of such action establishing a precedent in this country. For its business foresight in this direction, the company has earned the admiration of British electrical engineers and established a permanent claim on the support of all patriotic users of arc lamp and battery carbons. The obligation is all the more binding in that the works have been built on a generous scale. On the same site a large conduit works has been built, and is kept busily going with orders.

The Site.—The land on which the workshops have been erected is situated at Witton, some three miles from Birmingham, and comprises a total area of one hundred and five acres, divided into two unequal portions of forty-two and sixty-three acres respectively by the Tame Valley Canal. It is on the former that the works have been built, the latter being held in reserve for extensions, workmen's cottages, &c. The canal is accessible by means of a private dock, and the London and North Western Railway, which borders the ground, is also available, though it has not yet been deemed advisable to run a siding from it. Adequate facilities are thus afforded for the transport of raw material and the shipment of completed goods.



EXTERIOR VIEW OF WITTON ENGINEERING SHOPS AND FOUNDRY.

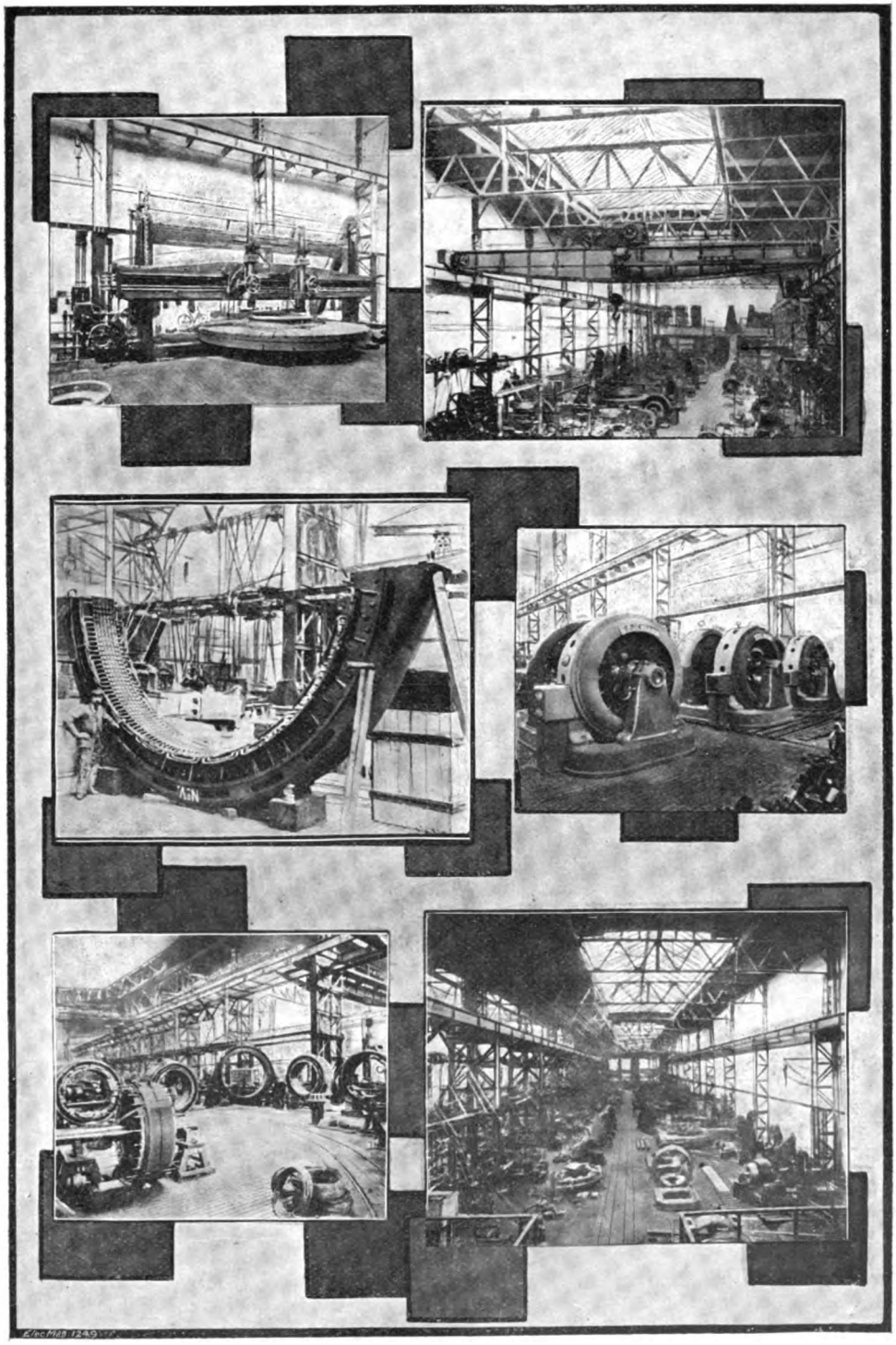
THE ENGINEERING WORKS.

The large machine shop and its adjoining foundry, power house, and testing department makes up the electrical manufacturing portion of the works so far laid down. Every thought has been devoted to the lay-out of the buildings, and a plan adopted which, while giving departmental independence, admits of organised co-operation and a regular progression of parts from the crude material to the finished state. The foundry, for instance, is some distance from the machine shop, as is also the power house and testing department. Each building is in close touch with the machine shop by standard gauge railway track served by an electric locomotive. This isolation of the buildings was decided upon as conducive to extension without any one department interfering with another.

It is almost needless to say that the works are operated entirely by electric power, though, contrary to the practice at Manchester, direct current has been adopted instead of polyphase current. The necessary electrical energy is furnished from the power house, which contains direct-connected steam plant aggregating about 700 kw. in two large and one small unit. One of the larger continuous-current sets is furnished with slip rings from which polyphase alternate-currents can be derived. A three-wire distribution system is in use, at 230–460 volts, the former for lighting and the latter for power. Separate balancers are provided in the various shops for equalising the load on that particular section. The generators and motors are all the company's own design and make, as also are the arc lamps for lighting.

The Machine Shop.—The following dimensions of the machine shop at Witton may serve as some guide to the scope it affords for the production of the

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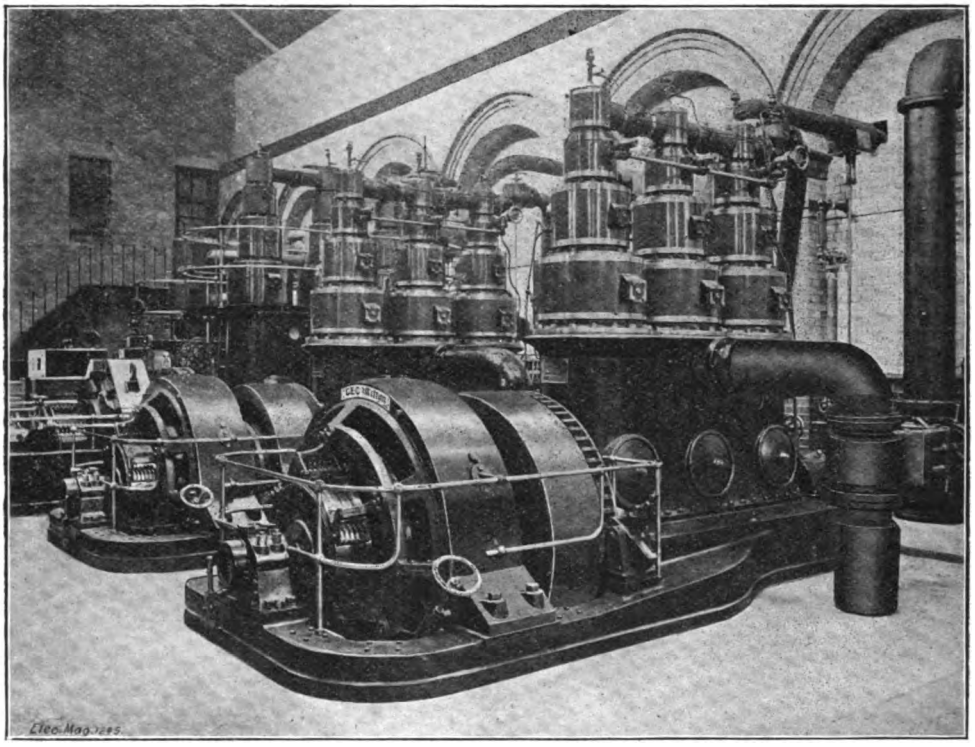


General Views of the Witton Engineering Shops.

24 ft. Motor Driven Boring Mill.
Stator of 1500 kw. Alternator.
Rotors and Stators of large 3-Phase Motors.

North Bay in Engineering Shop.
250 kw. Motor Generators for Manchester.
South Bay of Engineering Shop.

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GLOUCESTER ELECTRICITY WORKS G.E.C. PLANT IN FOREGROUND.

largest types of dynamo electric machines. It is 340 ft. long, and comprises two bays each of 70 ft. span, adequately lighted from the roof. Both north and south bays are served by electric cranes of thirty and fifteen tons capacity controlled from cages underhung from the cross girders. The east end of the shop, which is in touch with the foundries and canal, is devoted to stores for raw material and finished parts of motors, an arrangement which involves a minimum of handling. Similarly the passage of the raw material to the various machine tools has been properly organised. The tools themselves have consequently been carefully grouped for the processes of milling, planing, slotting, boring, turning and drilling, all of which are under the separate supervision of foremen who are specialists in their own particular class of work. These foremen also superintend the handing in and out of special jigs and tools for their machines, though the making of these jigs and tools is conducted in another department contiguous with the general material stores and its own special tool stores. The south bay accommodates the smaller machine tools, and in the north bay are the heavier tools, essential for dealing with the parts of dynamos and motors of the largest capacity such as the company has been building for some time past. The lighter tools are belt-driven from a line shaft operated by three motors, but all large tools are provided with one, two or three independent motors, according to the purpose of the tool itself. A large 24 ft. 6 in. boring mill, for instance, is driven by a 23 h.p. motor. Following the modern practice of using portable tools, a special bed has been laid down, 75 ft. long by 21 ft. wide, on which all heavy parts are placed. The portable tools are then set to work on them for planing, slotting and drilling as the case may be, and the completion is thus hastened, in that the particular parts, which may weigh several tons, have not to be handled and rehandled by the crane. Special emphasis must be laid on this operating feature, as it is conducive to quick but accurate machining,

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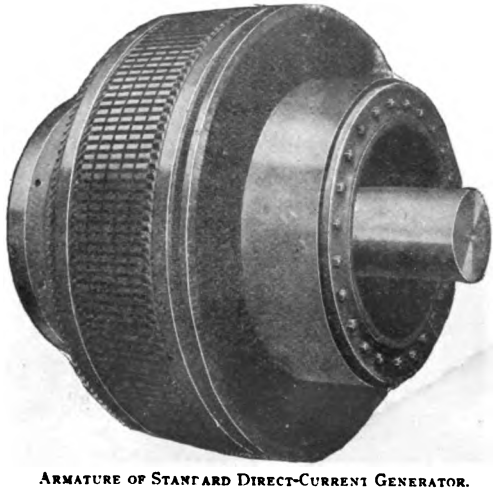
and in the main enables the management to promise prompt delivery of machines ordered, even if they be of the largest size. The same bay accommodates the punching and stamping departments, for the production of armature and stator cores.

At the west end of the north bay are two galleries, one devoted to the winding of armature and field coils, and the other, the upper one, is given up to brass work. The last-mentioned gallery extends over the offices, which are at the end of the south bay.

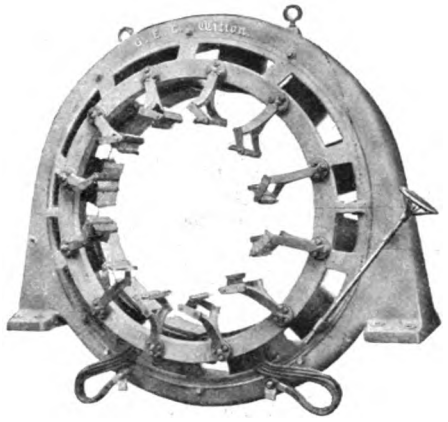
TESTING DEPARTMENT.

The motor and dynamo-testing department adjoins the power house, and a number of raised beds have been built for fixing the smaller motors at a convenient height from the floor. These beds are of concrete with girder clamping rails on the top, and to avoid straggling leads which are generally scattered over the surface of tests plates, a hole has been left in the concrete through which cables can be passed underground from the switchboard or instrument table. Adjoining the test beds is a painting shop, into which the motors are wheeled on trolleys, running on a track, where they are painted without further handling, and finally passed on to the packing department.

The Foundry.—The largest iron and the smallest brass castings for the dynamos and motors emanate from a large foundry built separately from the machine shop and the power house. It is near the canal,



ARMATURE OF STANDARD DIRECT-CURRENT GENERATOR.



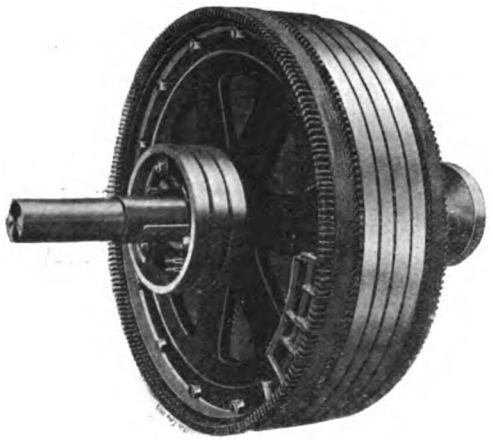
FIELD, YOKE AND BRUSH GEAR OF STANDARD DIRECT-CURRENT GENERATOR.

and is fitted with two 5-ton cupolas and a number of furnaces. The building is in two bays each 200 ft. by 50 ft., and the moulding floor is served with two 3-motor electric cranes of fifteen and five tons capacity respectively. Part of the same building is the smithy and pattern shop. A quantity of moulding sand has been "struck" in the grounds, which is specially useful for foundry purposes.

DYNAMO AND MOTOR PRODUCTS.

Direct-Current Generators. — Standard lines of direct-current generators have been laid down in two distinct types. One of these ranges up to 100 kw., and the other from 100 kw. up to the largest sizes required. The smaller pattern has the field frame and poles cast in one piece. The bearing brackets are cast separately and bolted to machined surfaces on the main carcase, making a compact and neat machine. The field coils are wound on circular bobbins, and after baking and varnishing are slipped over the poles and then the laminated pole-pieces are securely fastened to the pole by countersunk screws. The armature is of the drum slot type, former wound, the core being well provided with ventilating spaces. The windings are supported at both ends by two flanges cast in one piece with the end plates of the armature core. In the building up of the commutator a special feature is made of the micanite cones between which the segments, are clamped, these cones being prepared from carefully selected mica sheets held together by a high

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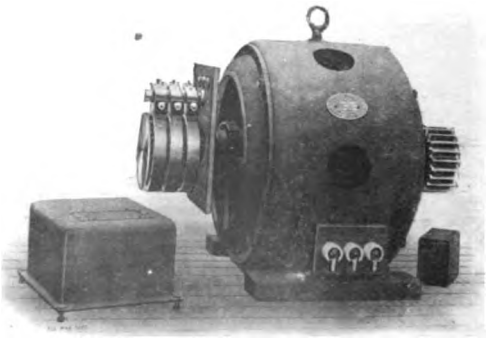
ROTOR OF 500 H.P. INDUCTION MOTOR.

quality resinous compound; the result is that the cones are well united to withstand the strains due to centrifugal force without cracking. Carbon blocks are used for the brush gear, and the machines are so designed that sparking between no load and full load is entirely absent. All parts are made strictly to gauge and consequently can be readily interchanged.

The larger generators for traction and power work represent a splendid line of machines carefully designed with a view to large overload capacity with due regard to temperature rise. The field frame is cast in halves, split horizontally, and the poles are of steel with laminated pieces holding the coils firmly in position. The armature core is assembled on a massive cast-iron spider, and ample ventilation is afforded through the core and end plates. An extension of the spider boss forms the coupling for the engine which drives the machine. An extension on the opposite side of the spider provides for the commutator, which is assembled separately and afterwards securely clamped in position. For purposes of equalising the heavy currents passing through the winding special equalising rings are fixed behind the commutator on the armature spider. A large cast-iron ring, turning in a machined annular space, carries the brush gear, which comprises a set of holders and brushes for each pole. Each spindle carries a row of carbon brush holders, and in every case the hinge of the swinging arm forms no part of the circuit, flexible leads connecting the fixed and moving portions. The brush holder ring is rocked from a large handwheel through a suitable rocking spindle. The connections between the spindles are made through insulated rings of copper, arranged at back of the main ring. Heavy flexible cables also connect the terminal ends to a substantial sweating socket fixed to but insulated from the field frame.

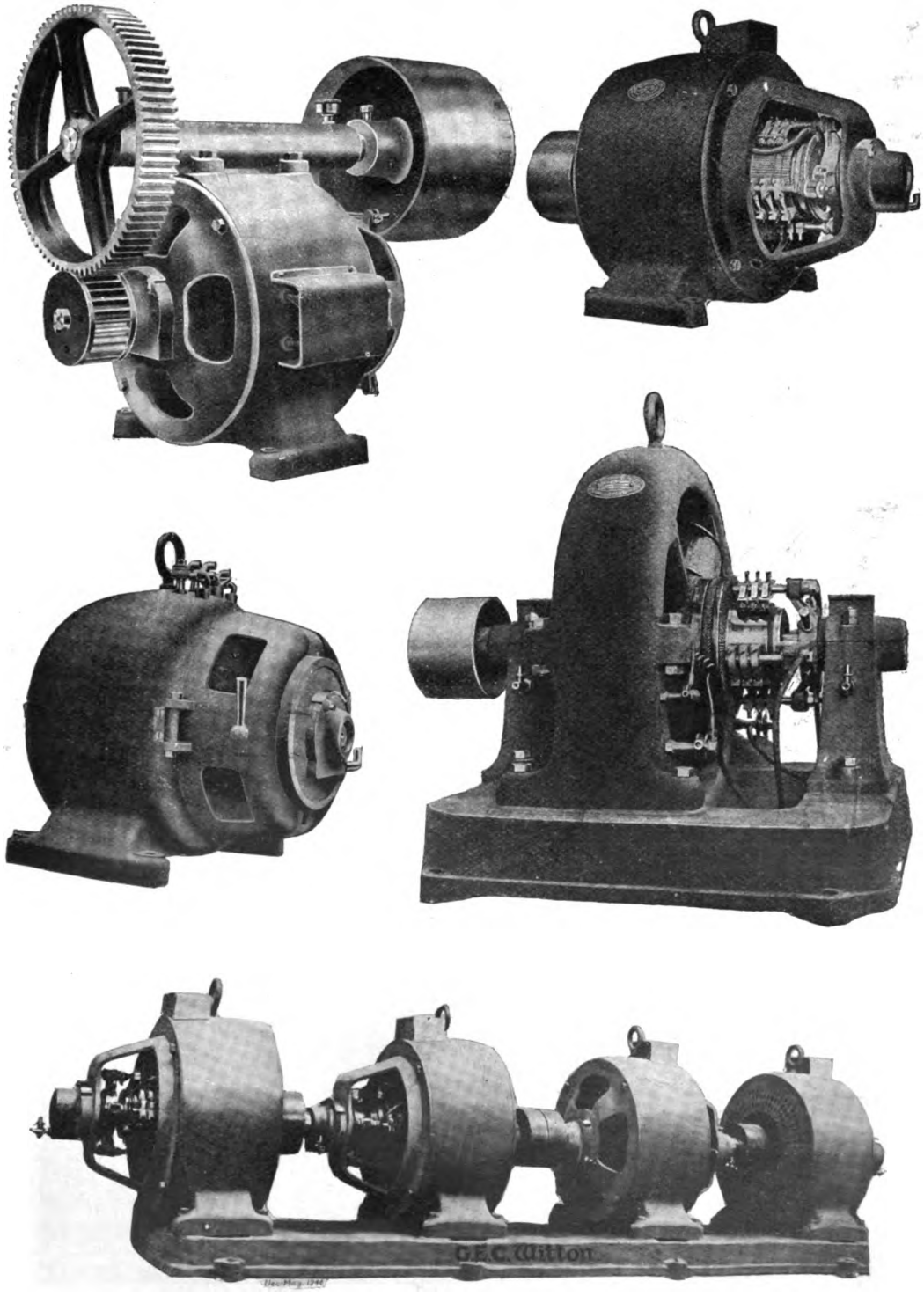
Direct-Current Motors.—These machines are similar in design to the smaller pattern of dynamos and are made in four types: (1) open protected; (2) semi-enclosed; (3) enclosed ventilated; (4) totally enclosed and dust-proof. The electrical parts of the machine are essentially the same in each case, the modifications which give the various forms being made in the bearing end plates. This will be readily gathered from the illustrations we give of the machines herewith. The capacities vary from 1 to 150 h.p., and motors of the largest sizes are also built to order. Rating of the motors depends on the class of load, the outputs being based on a certain temperature rise, after testing at full load for six hours. For intermittent working, a load factor of 50 per cent. is assumed, and a certain temperature rise allowed, but for lower load factors a higher temperature rise is permissible. It is worthy of note that the bearings are so designed that the motor can be worked in any position except with the spindle vertical.

Alternating-Current Motors. — Motors for alternating-current work are manufactured for single-, two-, or three-phase circuits, and are of the synchronous or induction type, as may be required, all



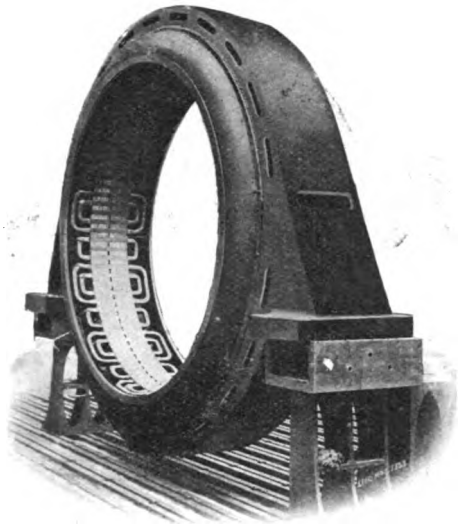
STANDARD TWO-PHASE MOTOR.

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Types of the General Electric Company's Standard Electrical Manufactures.

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STATOR OF STANDARD ONE-PHASE ALTERNATOR.

but the smallest sizes having slip-rings. The stator windings are in semi-enclosed slots, to ensue high power factor, the coils being carefully insulated with micanite. The top of the slot is afterwards closed with a hardwood wedge. The rotor is of the induction type, copper wire or ribbon being used according to the size of the motor. The ends are brought out to phosphor bronze slip-rings which are carefully insulated from the shaft and from each other. Oil ring lubrication is adopted for the bearings, oil throwers of large diameter being fitted to keep oil from the rotor windings. These motors are built in standard sizes from 1 to 150 h.p., and any supply voltage.

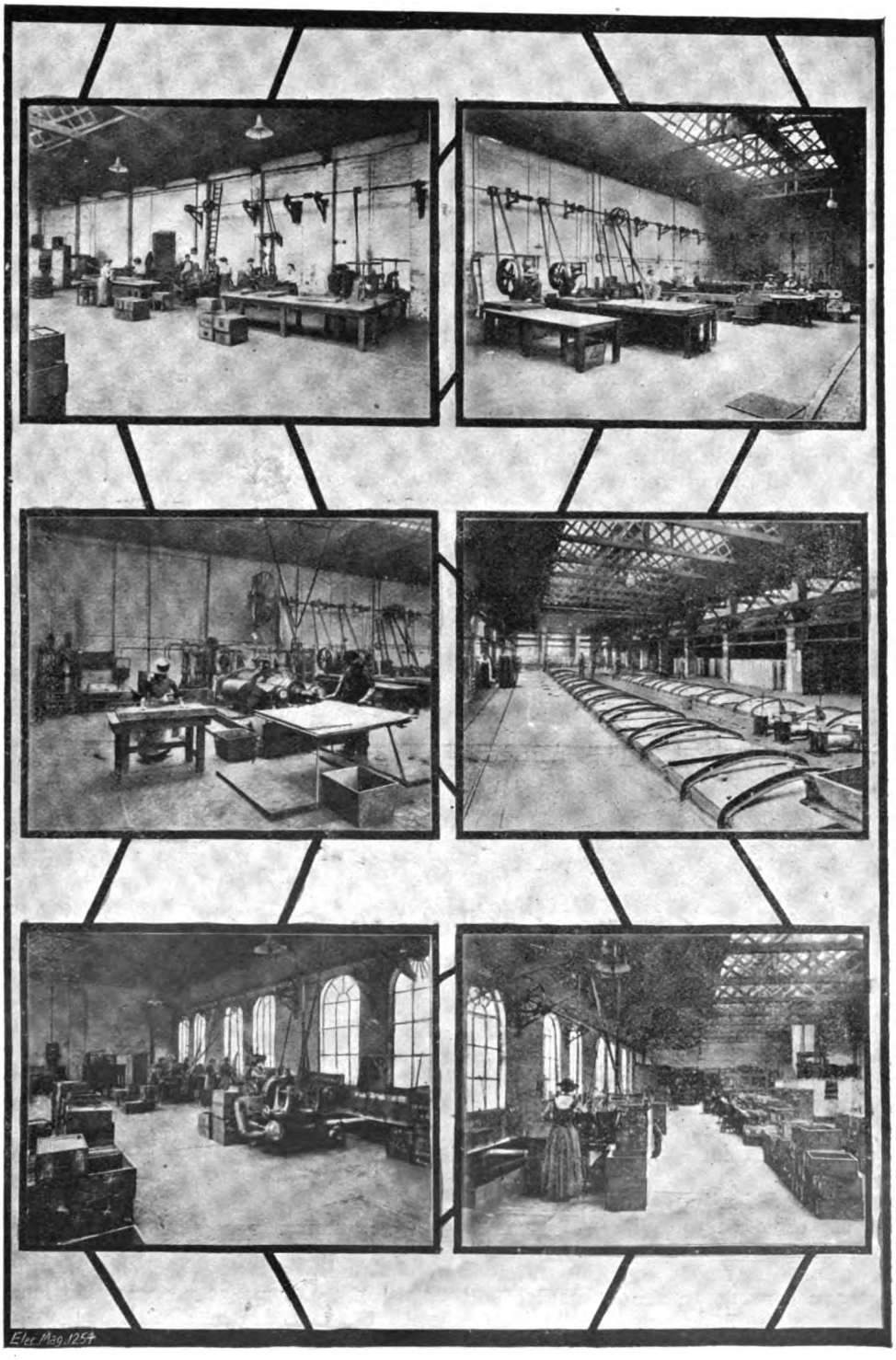
Motor Generators and Balancers.—Numerous examples of composite machines have been built at the works, and a standard line for motor-generators, balancers, boosters, &c., has thus been got out. With the growing use of rotary converting machinery for sub-stations a demand for certain combinations of machines has arisen, and it is worthy of note that large orders have been executed at the Witton works for various machines of this class. At the time of our visit we saw a number of very large sets going through the shops for the East Rand mines, the Manchester Corporation, Sunderland Corporation, and Aston, &c. &c.

THE CARBON WORKS.

We had looked forward with no little interest to our visit to Witton, and though agreeably surprised at the size and organisation of the Engineering Works we were not prepared to find the Carbon Works laid out on so extensive a scale. The buildings cover no less than four acres, and the various processes of carbon manufacture conducted in them engage the attention of about two hundred hands. As previously remarked, we feel that this enterprising move on the part of the General Electric Company deserves the unqualified support of every British user of the commercial products of carbon. The fact that the bulk of our carbons are made abroad, in works situated outside the range of observation by the user, should prompt engineers and trading houses to support a concern whose factory is at all times open to their inspection. The advent of enclosed arc lamps has made it more than ever essential that carbons of the highest quality only should be used. It is only by the employment of modern methods of manufacture that those impurities which impair the efficiency of this pattern of lamp can be reduced to a minimum, and this circumstance strengthens the claim which the only British makers of carbons have upon all the users of such products.

After a long period devoted to the laborious training of local hands for working the various machines, the manufacture of the carbons has been placed on a substantial footing, and a regular annual output of thirteen million feet is now possible. The raw materials, after being carefully selected, an operation requiring close supervision, are ground up to a fine powder and passed through a number of rolling mills. The materials are then mixed in specially designed machines and from these they issue in such a condition that on the application of pressure the finely divided particles will adhere closely. In this state the powder is compressed into cylindrical blocks, which are placed in a powerful hydraulic press. The carbon is then squirted through a die of a suitable size, it issues from this in a continuous rod, which is cut up into long rods of a length convenient for baking. An in-

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Views in the Carbon Works, Witton.

Pointing Ends of Carbons.
Hydraulic Press Squirting Carbons.
Machine for Pointing Carbons.
Carbon Battery Plate Shop.
View of Baking Ovens.
Coring Carbons.

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genious arrangement effects this cutting automatically, and at the same time prints the manufacturer's name and marking on the carbon rod. The resulting rod is of biscuit consistency, and can be easily broken in the fingers. By the use of different dies either solid or cored carbons can be squirted in these machines. Similarly rectangular rods for carbon plates are produced. The next process is the baking, which requires great care and skill. The oven house is a long building with the baking ovens below the floor level arranged down its centre. The ovens consist of two long rows connected at the ends so as to form a continuous series of thirty-six large chambers. They are fired by means of generator gas, which is produced for the purpose by means of three large specially designed generators—this gas is led to the ovens down a flue which runs between the two rows of chambers. Special connectors enable the gas to be admitted into any desired chamber in which it is burnt. The ovens are of special design for the manufacture of electric light carbons, being so arranged that the temperature is completely under control and can be very gradually increased to a maximum of nearly 3,000° Fahr., and afterwards gradually cooled down. This system provides for a utilisation of all the waste heat, thus effecting the maximum economy.

The carbon rods previously tied in bundles are placed in long fire-clay pots and packed all round in carbon powder to exclude the air. A very large number of these pots is necessary, all of which are made on the premises. The pots full of carbon are put in the furnace chambers, in which they remain for several days until they are gradually heated to the maximum temperature required and gradually cooled as described above.

When sufficiently cooled the carbon rods are removed to the Stores Department, where they are carefully stacked. They are afterwards cut into various lengths according to requirements, and then pointed and cored. The latter process is done on a special machine, the soft carbon being squirted through a hole in the centre of the rod and afterwards dried in special ovens. The carbons are made in three grades, the "Apostle," the "Imperial Crown," and the "Nubia," the latter being of very high quality and specially suitable for enclosed arc lamps. We must not omit to refer also to the large quantities of battery carbon plates and agglomerate blocks which are regularly made up in the works. The former are enlarged in the upper end by a special process which provides for the terminal screw and at the same time makes the plate homogeneous throughout, thus reducing the internal resistance of any cell with which it may be used.

The various processes are exceptionally interesting to follow, and the works well repay a visit by any large consumer of its chief products. Needless to say, the various machines are driven by electromotors throughout. The mixing and rolling plant are operated by large G. E. C. motors fixed in a separate building, the presence of so much carbon dust tending to cause heavy sparking and flashing at the brushes.

The manufacture of high-grade arc lamp carbons as turned out to-day, requires the most careful scientific control throughout all its stages, very much more so than is generally imagined. We found the works provided with a well-equipped chemical and physical laboratory from which all the processes of manufacture and the material in its various stages is controlled day by day. The elaborate arrangements for testing the finished products are also worthy of mention. Here the carbons are carefully tested for life, candle-power, steady burning, ash deposit, &c. &c., continuously. Recording instruments are used so that the most complete records of the electrical qualities of the carbons can be obtained, so that no opportunity is lost of finding out possible methods of improving the processes of manufacture or the quality of the carbons.

Whilst on the subject of the carbon-making industry, it may be interesting to record the fact that in the course of Mr. Arnold-Foster's speech on Saturday, April 1, he dealt at considerable length with the question of foreign competition in the manufacture of carbons.

The Secretary of State for War reminded his audience that some time ago he found that three-fourths of the carbons for

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electric lamps used by the Admiralty were made in France. This was a very grave matter, as if the supply of these necessary things were to run out while this country was at war, the lives of hundreds of men might be sacrificed through their inability to guard against a torpedo attack. This state of affairs, however, he was pleased to say, had now been altered, and a very large proportion, if not the whole, of our electric light carbons were now manufactured in England.

Despite the up-hill fight which the General Electric Company, Ltd., have had, owing to the "dumping" operations of Continental firms, they have been successful in obtaining a very firm grip of the British markets, and have also been appointed contractors to the Admiralty, War Office, and the India Office.

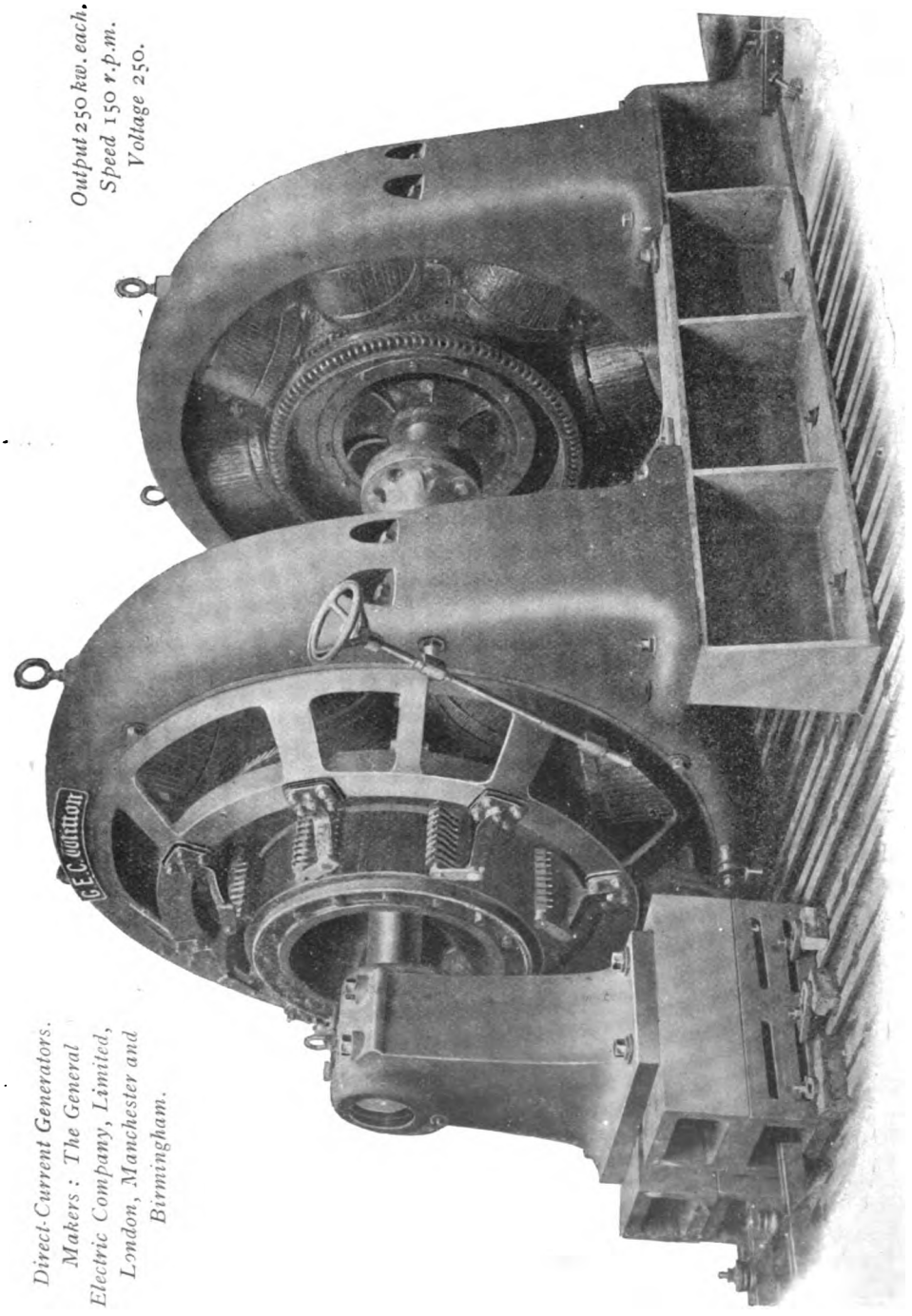
THE CONDUIT WORKS.

Between the railway and the engineering works buildings have been erected and special machinery installed for the manufacture of wiring conduits. A special quality of steel tube is produced, and machines are also at work making end fittings, elbows, tees and joint boxes for the "Union" conduit system. The necessary castings required are taken from the foundry to which we have already referred. All the buildings on the Witton estate are wired throughout with this particular system. The Company are now making a speciality of their insulated conduits, known as "Union Papristeel." These insulated tubes have lately come greatly into favour. The insulation is inserted as a continuous tube, and the steel sheathing drawn tightly over it; the whole then being thoroughly impregnated with enamel and stoned. The lining never sags, and cannot be drawn out of the tubes. This is, undoubtedly, the most reliable form of conduit on the market, and is undoubtedly the system of the future.

Conclusion.—We cannot conclude this brief account of an important engineering enterprise without reference to the business capacity and organisation of the General Electric Company, which brought to a practical solution the many problems confronting it for the expansion of its business in this country and its colonies. For many years the operations of the parent company were seriously hampered for want of a large works in which dynamo and motor machinery could be produced on a large scale; and by reason of the restricted capacity of its other very extensive establishments, the building of the factories at Witton was decided upon after due consideration by the management. With this magnificent asset at disposal it is now possible for the company to undertake electrical manufacture on a scale equally as ambitious as that attempted by any other concern in this country, and with equally good results.



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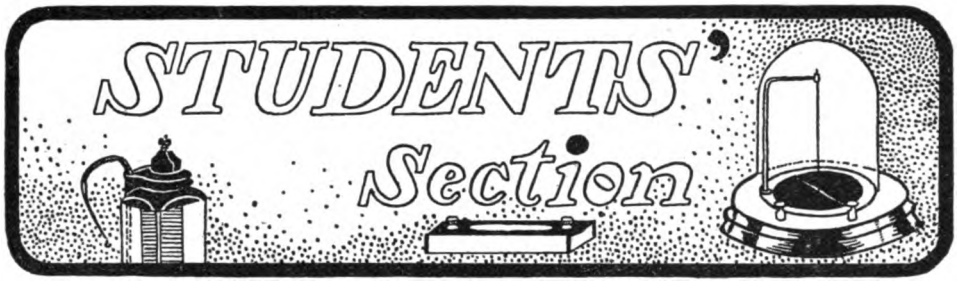


Output 250 kw. each.
Speed 150 r.p.m.
Voltage 250.

Direct-Current Generators.
Makers: The General Electric Company, Limited, London, Manchester and Birmingham.

Standard Types of Electrical Apparatus. IX.

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Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

The Training of Engineers.

By H. H. BROUGHTON.



NOWADAYS one finds it next to impossible to peruse an engineering journal or newspaper without coming across an article on the training of engineers, or disparaging remarks on the lack of systematic education in England; the latter often from the pens of enthusiastic journalists who hurry their intellectual efforts into print without giving sufficient thought to the subject, or more often writing merely from hearsay, or what they imagine to be true.

The existing systems on the Continent and in America have, from time to time, been very fully discussed in various technical journals, and rather than weary the reader, persons interested in this important question had best refer for information to the papers themselves.

The writer is no advocate of the sandwich system of training, *i.e.*, six months in the year at college, and six months in the works for some six or eight years. A better plan is to send the men into the works directly after they have completed their elementary education—say at fifteen years of age, and keep them there for three years working fifty or even sixty hours per week; at the end of this time, college train them for three years, and then finish off their education with another year in the works. The advantages of this system over the others are: That a man goes to college with a very fair knowledge of practice; he is conversant with the various processes; he knows something about the properties of materials and machines, and further he is fully alive to what will be expected of him when he rubs shoulders with the world. That the men start studying for their profession at an age when they are most capable of doing so, and when they realise the hard grinding work necessary to make a successful career, are in themselves sufficient recommendations for the system.

As to the colleges; in the first place every professor in an engineering department should be a practical engineer, or at any rate, should be conversant with the needs of the engineer—particularly the lecturers on chemistry, physics, and mathematics, above all. If the mathematicians would base their lectures to engineering students on practical problems, our colleges would pour into the country men armed with the tools necessary for tackling any problem they are likely to come across in their everyday work. As it is, we get men well up in beautiful theories, capable of integrating expressions with an answer of almost indefinite length, and regarding the solutions of differential equations as mere child's play; but set any of these mathematical geniuses—so-called trained engineers—a simple calculation for determining the strength or dimensions of a machine part or girder, and some hours after the engineer has got the part detailed, he hands in his solution, which nine times out of ten is absurd. The reason for this is apparent; the man having learned only pure mathematics finds to his amazement that it is of very

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little real use to him, and if he is sensible, he will promptly look for the thousand and one applications of mathematics to engineering problems—in a word—practical mathematics, as a way out of his difficulty. Thanks to Professor Perry, the Board of Education has done much to bring about a different state of affairs, and students are being well drilled from the outset in the use of mathematics to engineers.* The work of the pure mathematician must not be disparaged; they fail to recognise the requirements, and instead of developing the minds of students, as they think they are doing, they limit the horizon to θs, ϕs, $\int$ and $\iint$s, and their victims at the end of the course know as much about the strength of materials and the art of rapid and approximate calculation as the man in the street.

With physics, it is somewhat different. Here one learns something of the properties of matter, illustrating these with numerous experiments, in which accurate measurement and delicate handling are of great importance. Some parts of the subject may, however, be very much curtailed, the extra time being spent in a thorough study of other physical subjects, depending on the branch of engineering which concerns the student.

The chemistry taught is as useless as the mathematics—what a chemist thinks when he lectures to engineering students on ozone, fluorine, or the acids of phosphorus, or the carbon compounds, the writer cannot imagine. Surely he must know that this is the department for extending a student's knowledge of the materials *he uses*, this time from a chemical standpoint. The theory of combustion should be the basis of many lectures, as also should electrolysis, and in the laboratories, instead of analysing a great many salts, mostly chemical conundrums, would it not be better to spend the time in gas analysis, and in analysing the raw materials of the engineer? If this was done, the engineer would have no need to send off his samples of gas to the chemist every time he tests a boiler, and his specimens of iron and steel could be analysed under his own supervision. Unfortunately the syllabus to satisfy the various examining bodies, is a general one, and students in order to earn the grant, and gain their certificates must acquire this very unnecessary knowledge. We can, therefore, look for a reform in this direction, the outcome of which may be a new subject in the college prospectus—"Chemistry for Engineers."

Turning our attention to the most important branch of the engineering department—the drawing-offices and laboratories. The lectures must not only treat of machine design, but also practical geometry, mechanics, steam- and heat engines, and other subjects must be fully dealt with in order that students may derive the most benefit from the course. It is here that the intelligence of students can be brought to bear on practical problems. In going through a number of the foremost engineering colleges recently, the writer noticed, in many cases, a total lack of organisation in the drawing-office. Many a student, fresh from college, on entering the works finds that the drawing-office is not an artist's emporium; beautifully coloured drawings are not expected of him, neither are impossible wall-boxes, footstep-bearings, or plummer-blocks. Let no one think that there is anything to be gained by the *so-called* design of complicated machines, or engine details, or the design of machine parts by the aid of complex graphical constructions. No, the student can work up difficult graphical constructions when he really wants them, and ere the time comes when he is called upon to design complicated mechanisms he will have learned to think for himself, and the primary object of a college training should be to teach students how to think; this can only be done by carefully selecting examples from actual practice, giving a student details of machines coming under the branch of engineering in which he intends to specialise. Commencing with the *design* of the simplest details, having given just sufficient information to carry out the work, and producing a finished working drawing, is infinitely better than the far too common method of directly copying a drawing covering the wall of the office, and serving eighty or a hundred students, or from half a page

* The syllabus of the Board of Education could be much improved by recasting it.

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of a text-book, or a ridiculous wooden model. In this way the raw-boned recruit can be drilled into a first-class junior draughtsman, worth, at any time, a living wage. The writer on talking over this system, some time ago, with a member of a well-known firm of tool makers, was gratified to hear that he would be pleased to take at any time students trained in this manner, and start them at a reasonable salary, which shows that some of our English engineers are as good as their foreign competitors in this respect.

We now see the advantage of giving a theoretical training to men possessing some practical knowledge. The minimum time a student should attend the college drawing-office is three years, and the junior students should have their work checked by the senior students, and also be taught how to make good tracings and prints. As regards finishing the drawings, every dimension that would be required to make the pieces should be inserted, for the scaling of a drawing in the works by a workman with a two-foot rule leaves much to be desired, besides leading to frequent mistakes of a grave character.* Further, it is insufficient to merely put *m* or *f* on a surface to be machined. The degree of finish required must be specified exactly in order to enable the estimate clerks to get out a price from an inspection of the drawing. This can be readily accomplished by putting *M.S.*, *M.R.*, *P.P.*, *G.G.*, *S.S.*, &c., along the lines representing the surface to be machined *smooth*, *rough*, *polished*, *ground*, *surfaced*, &c. The various methods of preparing and issuing prints from the office to the works office, and thence to the different departments of the works should be explained, and the use of the drawings catalogue demonstrated.

The lecture work should be divided into two sections :

(*a*) The strength and properties of materials; and the theory of machine design.



ANNUAL DINNER OF STUDENTS SECTION I.E.E. HELD AT HOLBORN RESTAURANT, MARCH 16. MR. H. D. SYMONS, CHAIRMAN OF SECTION, IN THE CHAIR.

* In face of this it certainly seems strange that the Examining Bodies still adhere to a syllabus which was bad twenty years ago

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(*b*) The application of the theory to the practical example on the drawing-board.

In this way a student learns the use of the theory; if he is left to find it out for himself, the chances are that he fails to see it, and promptly shakes hands with, and joins the ranks of the men who think that Molesworth is enough, and sneer at the very mention of the words, "theory" and "college trained." If the lecturer is a good draughtsman, or is fortunate enough to have an assistant who is, then the designs can be got out in answer to all the sheets, and used by students only for reference, being regarded as standards. After a time when the men begin to feel their way, they can be started on estimating; the estimate being based on current prices of materials, and labour, and on the tool speeds, and these no doubt could be readily obtained from the many great engineering firms who take an interest in the education of their apprentices.

Before considering the laboratories it will be well for us to notice the college workshop and foundry (?), in which places students are usually taught to *play with* materials. There is not an unlimited market for toy steam-engines, model gas-engines, callipers and scribing blocks, as they quickly find out for themselves. Nowhere but in the works can a man be taught to handle iron and steel with any amount of certainty as to what the result will be, and if he could, is he not missing the main thing in his education—understanding the workman himself. It behoves the student to thoroughly master the details of this most important mechanism, in which the slightest friction often leads to disastrous results. In return the workman offers us his friendship, all he has to offer, and we often find under a rough exterior a wealth of culture and refinement, and a store of knowledge which passes our comprehension.

In only one college in the kingdom is workshop training carried out which nearly approaches to good practice, and this must be done at the expense of theoretical training. Surely a man is foolish to go to college in order to become a good workman; he can be that without any college training by working fifty-four hours per week for six or seven years with a good lot of rough diamonds as shop mates, and, at the same time, be paid for it.

The workshop is essential for preparing and making apparatus for the laboratories and lecture rooms, and for keeping the equipment in good repair, but beyond this as already said, its utility is questionable, and if only the writer's scheme was generally adopted one need not look to the college workshop for the practical training of our engineers.

The equipment and methods of conducting the laboratories is of great importance to the successful working of an engineering department. The larger the equipment the better, provided that the apparatus and plant is designed by an engineer. A common mistake is to equip the laboratories with research apparatus; for the bulk of one's students are not capable of, or have little inclination towards original research. It is, therefore, our duty to provide a good, substantial equipment, with all the recent improvements, and capable of working under every conceivable condition. The use of this will enable students to conduct tests of steam-, gas-, and oil-engines, turbines, pumps, materials, dynamo electric machinery, and so on, which they are likely to come across in their work, and not to lay down costly research apparatus which can only be understood by a very few students, and the professors. Research is the secret of progress in all engineering work, and we shall always have men ready to go in for it, and colleges to furnish the necessary plant; but before a man can attain this high standard, it is necessary for him to be trained to use apparatus properly, and read instruments correctly, and, therefore, in the first instance a good all-round plant is to be preferred. In the other case there is every possibility of the plant becoming unfit for research whilst students are going through the preliminary stages of their training.

Before concluding, a word or two on engineering students themselves may not be out of place. Students may be divided into four classes: (*a*) Very Good; (*b*) Plodders; (*c*) Practical; (*d*) Downright Duffers.

With respect to the two former classes little need be said; they possess a reason-

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able amount of originality; go about their business in a workmanlike manner; ask intelligent questions; spend plenty of time in private study; and read eagerly everything engineering they can lay their hands on. The *practical* student, so called, hides his extreme ignorance under the cloak of practice, and interrupts the lecturer from time to time, glibly asking what the subject under consideration has to do with practice. Every lecturer knows what it means to have a "*practical man*"—thank heaven they are rare—under him. How their senseless questions irritate one, and when they take the initiative in conducting a test—as they often do—it needs some will power to cope with them. The college career of these men is usually short; they quickly find that the lecturer can teach them nothing, and so they launch out again into the works, stick to the bench or the drawing-office stool, and find to their unbounded astonishment that younger men than they get the best jobs, and make greater progress: too late they learn of the chances they have missed—but enough. The students coming under the fourth class are interesting: their parents are often at fault, for after finding that their very good boy is a failure in several trades or professions, they decide that engineering is the thing for him, and look about for a good-natured works manager to take their son for a consideration of some £200 or £300, or send him to college to study electrical engineering. In the fulness of time he finds that getting up at 5.30 A.M. is a beastly fag, and attending lectures is all rot, and after this we see no more of him.

And now, in drawing this discussion to a close, let every student remember that there is something more than money to be made out of engineering. Each of us exists for the purpose of contributing something to satisfy men's needs, to propagate civilisation, and to further progress.

Let us then, instead of feebly protesting against fate, look upon our daily toil as a pleasure, and when old age comes upon us we shall look back on our life's work—it may be likened to a few stones in a gigantic building incomplete—with pride, and a feeling of content must surely come over us, knowing that our little was our best. In the end—then and only then—when all the inaccuracies in the design are made known to us, we shall realise our place in nature, and appreciate the infinite grandeur of the universe.

Finally, if our industrial supremacy can be maintained by technically training our men (and we have every reason to believe that it can) then let us go in for it whole-heartedly, and being prepared for it, we shall find we can face foreign competition unflinchingly.

Problems on Distributing Networks.—V.

By ALFRED HAY, D.Sc., M.I.E.E.

(*Continued from p.* 311.)

WE shall provisionally assume that the distributors are all of the same cross-section, so that the resistance of any section is directly proportional to its length. We may therefore, in taking moments of currents, use lengths instead of resistances. The "cut" network is shown in Fig. 16.

Two of our equations may be written down at once:

$$x + y = 20 \quad \ldots\ldots\ldots \quad (6)$$
$$u + v + w = 40 \quad \ldots\ldots \quad (7)$$

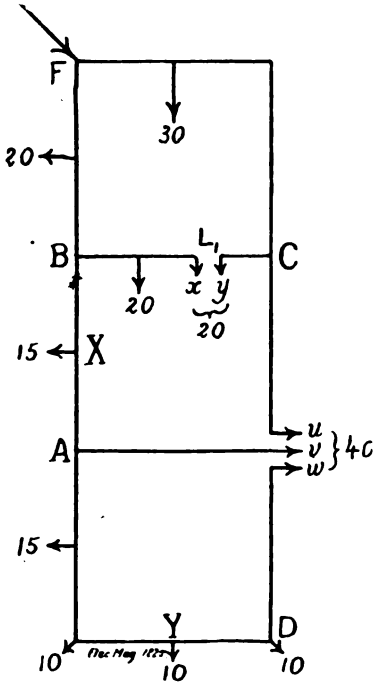


FIG. 16.

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The remaining three express the facts that (*a*) the drop from A to L_2 is the same along each of the two paths connecting these points; (*b*) the drop from F to L_2 along $FBAL_2$ is the same as that along FCL_2; and (*c*) the drop from F to L_1 along FBL_1 is equal to that along FCL_1; *i.e.*:

$$100v = 50 \times 15 + 100 \times 10 + 150 \times 10 + 200 \times 10 + 300w \quad \ldots\ldots (8)$$

$$50 \times 20 + 100(20 + x) + 150 \times 15 + 200(45 + w) + 300v = 50 \times 30 + 200y + 300u \quad \ldots\ldots (9)$$

$$50 \times 20 + 100(60 + v + w) + 133.3 \times 20 + 166.7x = 50 \times 30 + 200u + 233.3y \quad \ldots (10)$$

From (6) and (7) we find $y = 20 - x$ and $w = 40 - u - v$. Substituting these values in (8), (9) and (10), performing the various operations there indicated, and simplifying, we obtain:

$$3u + 4v = 172.5$$
$$5u - 3x - v = 167.5$$
$$3u - 4x = 75$$

Solving the last three equations, and then utilising (6) and (7), we find

$$x = 14.3; \quad y = 5.7; \quad u = 44; \quad v = 10.1; \quad w = -14.1.$$

Thus all the values are positive with the exception of w, which is negative. The point L_1 is therefore actually a point of lowest potential; but L_2 is not. The solution obtained, however, immediately enables us to find the true second point of lowest potential. For the negative sign of w indicates a current of that amount flowing *away* from L_2, towards D; at this latter point, a current of 10 amperes branches off, leaving 14.1 − 10 = 4.1 amperes flowing from D to Y. Now since the current leaving the distributing system at Y is 10 amperes, it is evident that the balance of 5.9 amperes must be supplied by a current flowing towards Y from the left-hand side. Hence Y is a point of lowest potential.

A word of explanation in connection with the establishment of the equations (8), (9) and (10), which express the equality in the drop of potential along two different paths connecting the same two points, appears desirable. In proceeding from F to L_1 along the path FBL_1, we must regard the current which flows down BX as a *branch* current (this current is obviously equal to $15 + v + 15 + 10 + 10 + 10 + w$). But in proceeding from F to L_2 along $FBAYDL_2$, the current which flows from B towards L_1 (and which is equal to $20 + x$) must be regarded as a branch current. This principle must be carefully borne in mind if confusion is to be avoided.

The values of x, y, u, v and w having been obtained, the distribution of currents in the entire network becomes known. This distribution is shown in Fig. 17.

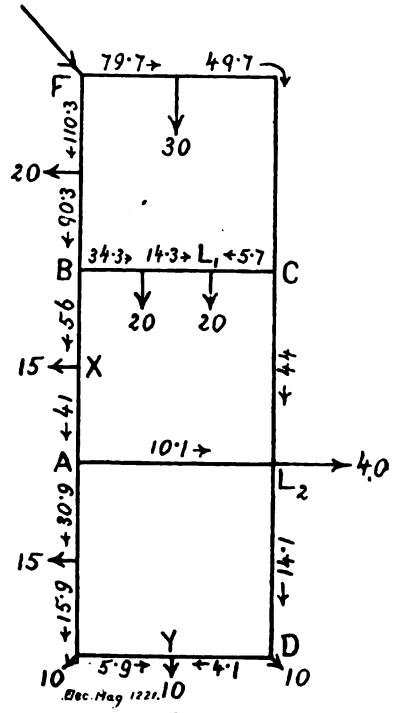


FIG. 17.

The calculation of the drop for each of the two points L_1 and L_2 now presents no difficulty: we have merely to take the sum of the drops along the various sections of the distributor. Assuming, for example, that the distributor has a resistance of .0194 ohm per 100 yds. (this would correspond to a cross-section of $\frac{1}{8}\square''$), we find for the drop from F to L_1, 2.25 volts for the single, and hence a total drop of 4.5 volts for the double main: and for the drop from F to L_2, 3.4 volts for the single, 6.8 volts for the double main.

An examination of Fig. 17 will, however, show at once that a distributing system with all the conductors of equal cross-section would be most unsuitable in this case. Thus, the first section of FB carries a current of 110.3 amperes, and there is a comparatively heavy drop along it, while the distributor DY carries only 4.1 amperes, and the drop along it is negligible. This at once indicates the desirability of increasing the cross-section of FB, and decreasing that of DY. Without any increase in the total amount of copper, we could then obtain a much smaller drop. Although in practice it would be inconvenient to have too many sizes of distributors, yet it is usual to employ several standard sizes, and in finally selecting the cross-sections we should choose the nearest standard sizes to those we wish to employ.

One of the main results of a calculation

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such as the one we have just carried out is that it gives important information regarding the part played by the various members of the distributing system; it frequently indicates where the cross-section of a distributor may with advantage be increased or decreased. It must be borne in mind, however, that any alteration in the cross-sections of the distributors (other than an all-round increase or decrease in the same proportion) will alter the distribution of currents, so that this will have to be re-calculated when any change is made.

General Case of Complicated Network Fed at a Number of Points.

We next proceed to consider the most general case of a complicated network of interlacing distributors fed at several points, and in dealing with this problem we shall make use of an important principle, known as the *principle of superposition.*

The current flowing in any member of a distributing network may be supposed to be replaced by two imaginary currents whose algebraical sum is equal to the actual current. The actual drop due to the current will be equal to the algebraical sum of the drops corresponding to the imaginary currents. Thus, let in Fig. 18 AB denote a conductor of resistance = .02 ohm, conveying a current of 100 amperes which, as shown by the full-line arrow, flows from

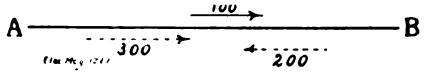


FIG. 18.

A to B, the drop of potential from A to B amounting to .02 × 100 = 2 volts. Then we may replace the actual current of 100 amperes by two imaginary currents, as shown by the dotted arrows in Fig. 18, one of which has a value of 300 amperes, and flows from A to B, while the other has a value of 200 amperes, and flows from B to A. The drop due to the current of 300 amperes is .02 × 300 = 6 volts, while that due to the current of 200 amperes is − .02 × 200 = − 4 volts, the *minus* sign being used because of the negative direction of the current. The resultant drop is 6 − 4 = 2 volts, *i.e.*, it is equal to the actual drop.

We shall consider another simple example

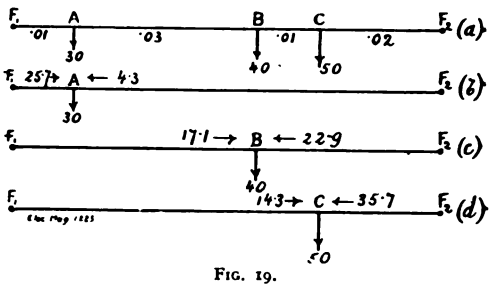


FIG. 19.

by way of illustration. Let F_1F_2 in Fig. 19 (*a*) represent a distributor loaded with currents of 30, 40, and 50 amperes as shown. The resistances of the sections F_1A, AB, BC and CF_2 of the (double) distributor are respectively .01, .03, .01 and .02 ohm. It is required to find the currents in the various sections of the distributor and the drop to the point of lowest potential. The simplest way of dealing with this problem is to use one of the algebraical or graphical methods already explained for this simple case. But we shall here solve it by using the principle of superposition, and shall assume that the actual distribution is replaced by the three distributions shown in Fig. 19 (*b*), (*c*) and (*d*), which are, when superposed, equivalent to the actual distribution, and in each of which there is only a single load current. For each of these simple cases we at once find the currents in the two sections of the distributor by regarding them as the currents in the two branches of a parallel circuit between F_1F_2 (F_1 and F_2 may be supposed to coincide, as they are at the same potential) and the point at which the load current branches off. Thus we find the currents indicated in the figure, (*b*), (*c*) and (*d*). In order to find the actual currents in the various sections of the distributor, we have simply to superpose, for each section, the currents flowing in that section in the cases (*b*), (*c*) and (*d*) in the figure. We thus find

Current in section:

$F_1A = 25.7 + 17.1 + 14.3 = 57.1$
$AB = -4.3 + 17.1 + 14.3 = 27.1$
$BC = -4.3 - 22.9 + 14.3 = -12.9$
$CF_2 = -4.3 - 22.9 - 35.7 = -62.9$

Hence B is the point of lowest potential and the drop is .01 × 57.1 + .03 × 27.1 = 1.384 volt.



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From Professor to Student.

IN the *Electrical Review* some months ago there was a description of the electrification of a railway in France. It was mentioned that the sub-stations were equipped with compound-wound rotaries in which the series turns opposed the shunt windings. I fail to see how such machines could be operated satisfactorily. Could you explain the working principles of such a machine?

Auxiliary rotary converters with series coils connected in opposition to shunt coils are used in cases where it is desired to charge secondary batteries from a traction circuit. Such boosting converters are connected in series with the main converters. At the commencement of the charge, when the battery p.d. is comparatively low, the normal charging current flows through the converter, whose voltage is at this stage low on account of the heavy demagnetising effect due to the series coils. As the battery p.d. rises, the charging current decreases, but since any decrease of current is accompanied by a rise of converter voltage (not only on account of the decreased effect of the series coil, but also on account of the increased effect of the shunt coil, which now has a higher voltage across it), the falling-off in the charging current is comparatively slight, and as a result the differentially wound converter automatically maintains a nearly constant current through the battery from beginning to end of charge (the drop in the current need not amount to more than 30 per cent.). It has the further advantage of rendering the charging current practically independent of the voltage fluctuations in the main circuit, thereby protecting the battery against the excessive currents which a sudden rise of the line voltage would occasion.

So far as we are aware, a differential compound winding has never been used in connection with main rotary converters supplying current direct to railway motors. The result of using such a winding would be to increase the drop still further with increasing load, instead of decreasing it as is the case with a cumulative compound winding. The statement referred to by our correspondent is either entirely in error, or has been adopted in connection with some very special arrangements of which no account has so far been published.

I HAVE some work to do with three-phase currents, rectified so as to charge accumulators, and shall be glad if you can give me any information regarding the construction and theory of rectifiers.

The most successful form of rectifier is that known as Nodon's "electric valve." It consists of an iron cylinder containing a saturated solution of ammonium phosphate. Passing through a plug of insulating material in the bottom of the cylinder is a tube consisting of an alloy of aluminium and zinc. The iron cylinder and the tube of aluminium alloy form the electrodes. Such a cell allows a current to pass freely through it in the direction iron to aluminium, but if an attempt is made to send a current in the opposite direction, a non-conducting film immediately forms on the surface of the aluminium, and the current is practically arrested. Hence if the cell is inserted into a circuit connected across alternating-current mains, a unidirectional or rectified current will be obtained. The efficiency of this form of rectifier is, according to some recent tests by Mr. G. W. Partridge, about 70 per cent.

The Cooper-Hewitt rectifier is intended for use on three-phase circuits. It depends on the fact that a mercury arc (*i.e.*, an arc consisting of incandescent mercury vapour) is easily maintained if a current passes from an *iron* electrode through the mercury vapour to a *mercury* electrode, but that it is impossible to maintain such an arc with a current flowing through it in the opposite direction (*i.e.*, from mercury to iron). The rectifier consists of a vacuum bulb whose lower portion contains a small quantity of mercury, which serves as the cathode, while into its upper portion are fitted four iron electrodes. The central one is the anode for the continuous current, and the remaining three are connected to the three-phase supply. The rectifier must be started by means of continuous current. Promising as this form of rectifier appeared when first described (in 1903), it has, for some unaccountable reason, not come into use.

I INTEND trying for the B.Sc. degree of London University. I have not passed the Matriculation Examination, and should like to know if there are any public examinations which are accepted by the University in lieu of this examination (I ask this as I have passed several examinations, including the Senior Cambridge Local with distinctions in various subjects). If it is necessary to take the three examinations, Matriculation, Intermediate and Final, how long would the operation take? What are the best evening-classes for intending students?

The only case (if we accept certain foreign examinations) in which exemption is granted from the Matriculation Examination is that of students who hold the Scotch School Leaving Certificate, having passed on one and the same occasion, in the Higher or Honours Grade, in all the subjects required by the Regulations for the Matriculation Examination. The Senior Cambridge Local Certificates mentioned by our correspondent would not be sufficient. Of course, it is absolutely necessary to pass the three examinations (Matric., Inter., and Final), and according to the University Regulations no student shall be admitted to the final examination for a degree until the expiration of *at least three years* after Matriculation, unless the Senate determine otherwise in some very special cases. We should advise our correspondent to choose the nearest institution—such as a University College, Technical College, or Technical Institute.

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The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. Consult it and save yourself much valuable time.

Notes on the Testing of Motor Meters.

By H. R. MOTT, A.M.I.E.E.



A GOOD motor meter should fill as many of the following conditions as possible :

Accuracy at all loads from $\frac{1}{20}$ to $1\frac{1}{4}$, reliability, low starting current, must be unaffected by external fields, as few moving parts as possible, suitable means of checking by a short time test, one uniform speed at full load for all sizes of the same make, low internal losses, low initial cost, small repairs cost, advantage if suitable for both alternate and direct current, if of the wattmeter type for alternate current, must be correct on a power factor, and unaffected by wave form of alternator, good dust proof cases and double sealing arrangement so that the meter proper can be sealed before leaving the Testing Department and only the terminal box left open. The actual tests to be made on the meters will, of course, vary with the purpose for which the meters are required, *i.e.*, a meter for an arc lamp or motor circuit will not need to be very accurate at low loads.

In general, the tests which require to be made on supply meters are :

Rate tests at various loads, correctness of clockwork ratios, starting current, insulation and in the case of wattmeters creeping (running on shunt) and correctness of alternate-current wattmeters on a power factor.

On receiving the meters from the makers they should be carefully examined to see that the cases are not damaged, and then stored away until wanted for testing. After having been fixed on the testing stands or benches the cases must be removed and the meters inspected to see that no packing or sawdust has got inside, and that all screws and connections are tight. The insulation of the coils to case and with wattmeters shunt to main coils and case should now be taken so that any defective meters may be rejected for repair without wasting time on further tests. The most convenient way of doing this is to have a pair of flexible leads from the insulation table, one ending in a metal rod to go into the meter terminal and the other in a spring clip to clip on to the dial or case of the meter. Wattmeters as received from the makers have one end of the shunt or pressure circuit connected to one main terminal so that whichever terminal is used the insulation given will be that of both coils in parallel to the case. Care must be taken when measuring the insulation of coil to coil to disconnect the end of the shunt from the main circuit.

The meters having satisfactorily passed the insulation test, the jewels should be tried to see that they are in good condition and have not been cracked in transit.

The method which the author has found the most satisfactory is to feel them with a fine and fairly long needle-point fixed into a small handle and used

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with the needle resting on the tip of the second finger, in this manner with a little practice it is astonishing what very slight roughnesses can be easily detected.

The next proceeding should be to check the clock ratios. The clockwork must be taken off and tried to see that it runs freely and the ratios checked in the following manner: Count the teeth in all the wheels up to the units dial and from this get the revolutions per second at the full load of the meter; it is then quite easy to determine the revolutions at any load for any time and also the testing constant. This sounds a long process, but in reality only takes a very short time. An example will, perhaps, make the above description clearer.

Clock Ratios and Constant.

200 volts, 10 amperes, T.H. wattmeter.

Worm on armature spindle = single thread 1
Teeth in worm wheel = 100
Ratio = 100

Teeth in worm wheel pinion = 60
Teeth in 1st wheel = 75
Ratio = 1.25

Teeth in 1st wheel pinion = 10
Teeth in 2nd wheel = 100
Ratio = 10

Teeth in 2nd wheel pinion = 10
Teeth in units wheel = 100
Ratio = 10

10 units = 1 rev. units wheel
= 10 rev. 2nd wheel
= 100 rev. 1st wheel
= 125 rev. worm wheel
= 12,500 rev. armature spindle.

If a = revolutions of armature at full load for δ units
β = full load of meter in B.T.U.

Then revolutions per sec. at full load $= \frac{a\beta}{3600\,\delta}$

In above case:

$$\text{Revs. per sec.} = \frac{12500 \times 2}{3600 \times 10} = 0.694$$

or 100 revs. in 144 seconds.

We can now find the testing constant from the formula

$$W. = \frac{C \times R \times 3600}{T}$$

Where W. = watts registered by meter
C. = testing constant
R. = revolutions in T seconds.

For finding the testing constant we must assume the meter to be correct, so that W. watts passing then we have:

$$2000 = \frac{C \times 100 \times 3600}{144}$$

or C. = 0.8

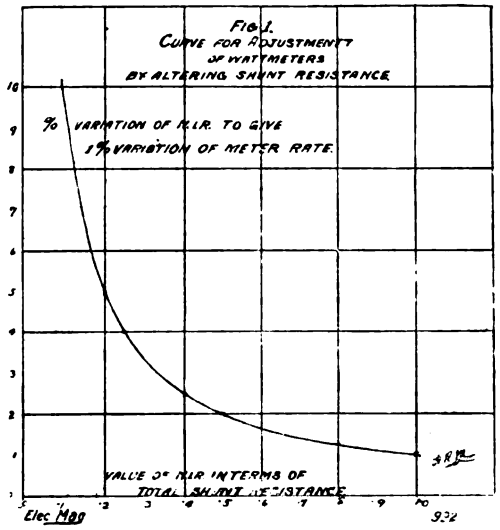
Having thus checked the clock and constant the meters may be connected up for test, and it will be convenient to connect up several meters of a size in a batch, putting all the main coils in series, taking care in the case of wattmeters that the shunt coils are disconnected from the main coils and joined directly to the source of supply.

The connections having been made as above, full load should be put on for some minutes before commencing to test and the meters allowed to run themselves into a steady condition. Rate tests are now taken at the loads decided on. For motor meters having a practically straight line law it will usually be sufficient if they are tested at say $\frac{1}{20}$ and full load in addition to the starting current. Meters not having a straight line law should be tested at several loads corresponding to the peaks of the rate curve.

Should the meters not be within the limits of accuracy required they must be readjusted. The method of doing this will vary with the make of meter, but will, in most cases, be one of two; either adjustment of some part of the braking arrangement such as the magnets of a T.H. or in the case of some wattmeters, alteration of the shunt resistance. Nearly all wattmeters will be found to have as the greater part of their shunt circuit a non-inductive resistance, and it is of this that the adjustment must be made. Fig. 1 gives a curve showing the percentage alteration to make in this coil to give 1.0 per cent. variation in the meter rate, for different values of the coil in terms of the total shunt resistance. In one or two special cases it may be necessary to adjust one of the coils of the meter or to insert new change wheels in the clockwork.

If three or more wire meters are used they must be tested for correctness on one coil alone. This is most easily done in the following manner. Having tested the meters with all the main coils in series, connect the coils all in opposition to one another and put a fairly good load on them, if the coils are correctly

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balanced the meter will not register. The starting load of a meter is, especially with the smaller size of meters, becoming more and more important with the increase of supply pressure, as a 200-volt 5 candle-power lamp only takes from 16–18 watts, and there may be many meters up to 10 ampere capacity installed where during the day there is only a 5 candle-power lamp on but on pretty continuously.

Meters up to 10 amperes capacity should start well with 0.75 per cent. of full load, from 10–100 amperes with 1.0 per cent. and from 100 amperes upwards with about 2.0 per cent. of full load.

After the meters have been tested they are numbered and the cases sealed. When putting the cases on just previous to sealing it is a very good plan to put a thin layer of rubber putty all round the join of the case and frame, as the majority of meter cases are anything but dust proof. It is next to impossible to make a meter case insect proof, as they will, if the case is proof, eat their way in along the insulation of the mains. The author has seen beetles having rides on the disc of even a Stanley meter, the joints of the case in this meter being perhaps the most perfect of any, as they are luted with red lead and screwed up tight.

The chief defects to be looked for in motor meters are :

(1) Sparking. This may arise from many causes, but in new meters is most likely to be caused by grit on the commutator, unequal tension of the brushes, by the commutator being slightly eccentric, or by the tension of the brushes being too light. The two first and the last cause are easily removed, but in the case of the third there is nothing to be done but truing the commutator.

(2) Bad jewel. This is easily detected as described above, and if defective must be replaced by a new one.

(3) In the case of wattmeters, broken shunt circuit. This is not a defect very likely to occur in new meters, and when it does is easily found by shorting the various parts of the shunt winding in turn.

(4) Creeping, or running on shunt. This is one of the most tiresome of all defects, as when it is at all pronounced it is very difficult to stop without affecting both the rate of the meter at low loads and the starting current.

(5) Defective or incorrect clockwork. These are easily found by careful examination and counting the ratios as before described.

(6) In mercury motor meters, air bubbles in the mercury, creeping of the mercury and impure or oxydised mercury. The air bubbles can generally be got rid of by gentle shaking, but if the mercury is impure or dirty the only thing to be done is to empty it out and refill the meter with fresh mercury.

Some motor meters are badly affected in the event of a short occurring on the installation to which they are connected or by a heavy overload for a short time ; if this is found to be the case with the type of meter in use it will be a good plan to short them, before testing, through a fuse of about 50 per cent. larger capacity than the meters, as in most cases all the change in the rate is caused by the first short.

Inspection of Meters while on circuit.— The periodical inspection of meters when installed on the consumer's premises will be found to save many from being returned to the testing department, as a considerable number of the faults which occur in meters on circuit will be avoided by cleaning, and most of the others can be repaired without removing the meter.

The faults which are most likely to

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develop in motor meters while on circuit are :

Sparking, bad jewel, disc working loose, creeping, broken shunt, grit in magnets.

Sparking.—This almost invariably happens after some little time, and is very difficult if not impossible to prevent. One of the chief causes is vibration, which cannot be entirely overcome however carefully the meter is fixed. Another cause is the thin film of oxide which forms on the commutator if the meter has been standing for some time. On starting up the meter will commence sparking, and in this case sometimes stops sparking after a few minutes, but usually continues and results in badly scoring the commutator and brushes.

The effects of sparking are peculiar, as sometimes it will slow the meter at all loads, but most usually will slow it considerably more at high loads than at low, while at others it will stop it at low without affecting it at high loads. The only way of preventing this is by, (*a*) exceedingly careful adjustment of the brushes when testing both for tension and squareness of contact with the commutator; it is no use passing a meter out if the brushes are ever so slightly on edge or if one leaf bears harder on the commutator than the others; (*b*) fixing the meter in a place as free as possible from vibration and where it will be at a fairly uniform temperature; (*c*) periodical inspection. This is perhaps the most important of all, as a few minutes spent on a meter periodically will often prevent the sparking developing to a serious extent.

Bad jewel.—This will probably only occur where there is much vibration, and can easily be found as described previously.

Disc Working Loose.—This frequently happens, more especially with alternating-current meters. A good way to stop it is to fit the screws clamping the brake disc to the spindle with small lock nuts.

Creeping.—This is usually caused by vibration and is not of very common occurrence with motor meters, and when it does occur is rather difficult to stop without affecting the low-load rate of the meter. One of the best cures is to put a small dab of paint on the disc and sprinkle a few iron filings on it before drying; in nearly all cases this will stop the creeping while having practically no effect on the low-load rate.

Broken Shunt.—In most cases this is caused by the joints between the various sections of the shunt winding being soldered with a fluid flux instead of resin. Next to the joints the armature and compounding coil are the most usual places for breaks, if in the armature it will usually show by the meter slowing up or stopping at two diametrically opposite points. Breaks in other places can be readily located by shorting the various parts as described before.

Grit in Magnets.—If the meter is installed in a dusty position or if the case does not fit quite tight, it will frequently be found that the magnetic particles in the dust will collect on the pole-tips of the braking magnets sometimes to such an extent as to rub on the disc, thereby slowing the meter at low loads. Should any pieces of the shellac varnish chip off the coils of the meter at any time they are almost sure to fall on the disc and be carried round to the narrow pole gaps and to get jambed there. The easiest way to get rid of these, is to pass a piece of stout card between the magnets, sweeping the pieces of grit to the edges, when they can easily be got at and removed.

Water Resistances.

By E. KILBURN SCOTT, M.I.E.E.

LIQUID resistances suffer from certain mechanical disadvantages, and from the fact that the liquid has to be renewed regularly, is therefore liable to constant change. They are, however, gradually growing in favour, especially for motors connected to electric supply mains where it is important to take up current gradually, in order not to disturb the lighting.

Indeed, at Bradford, liquid resistances fitted with slow action dash pots, used to be compulsory.

Liquid resistances are also much used for crane work both for direct-current and polyphase motors. With the latter there is no electrolytic action, and the plates wear down equally, whereas with direct current if there are plates to each

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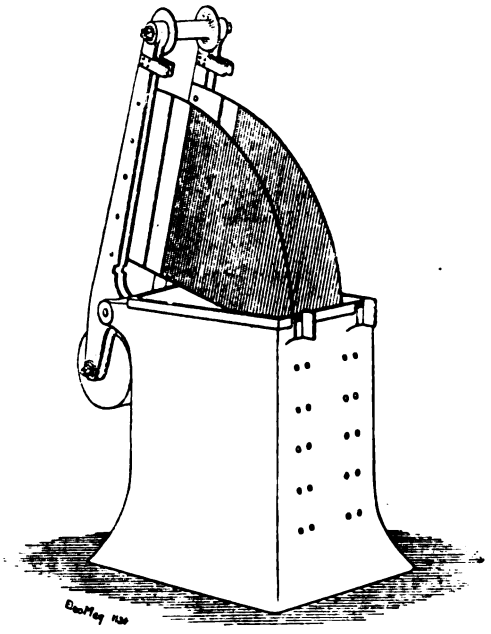


FIG. 1.

pole the connections must be reversed occasionally. Even with the electrolytic action, however, many makers of electric cranes prefer the water resistance for its simplicity and cheapness and true regulation. A typical water resistance is shown in Fig. 1.

On first dipping the plate into the liquid considerable resistance will be in circuit, which is gradually diminished, and finally removed by pressing down the handle till the copper contacts short circuit the water.

The constructional details vary a good deal with various makers. Some employing a metal containing vessel, and others porcelain as shown in Figs. 2 and 3. In some cases the plates are raised and lowered by a screw gear as in Fig. 3, and in others by a hoisting gear as Fig. 4, whilst in case of reversing for crane work, Fig. 5 may be taken as typical. Fig. 6 shows a design in which a rotatory acts similarly to a switch arm being in contact with the fixed plates when resistance is cut right out.

Water resistances have been found extremely convenient in alternate-current traction, Ganz, in particular, favouring the class of apparatus. As the tensions are fairly high they have hit on the plan of moving the liquid instead of the metal parts. This is usually done by compressed air pressing on the water and forcing it into the resistance chamber, where it gradually creeps up the sides of the metal plates. In shutting off current all that has to be done is to open a cock, and let the water run out, and it will be seen how easy it is to have safety devices attached to this cock.

The resistance is of ordinary hydrant water per square foot cross-section and foot in length is approximately 100 ohms.

When diluted with commercial table salt the resistance varies as follows :

Percentage of Salt by weight.		Resistance ohms.
.23	..	7.84
.46	..	4.65
.70	..	3.12
.93	..	2.38
1.16	..	1.9
1.39	..	1.48

When diluted with commercial sulphuric acid :

Percentage of Acid.		Resistance ohms.
.174	..	4.12
.435	..	1.75
.724	..	1.10
.985	..	.85

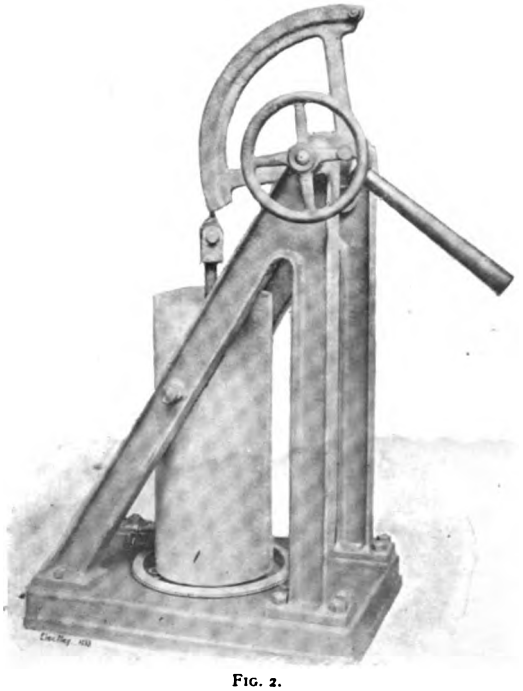


FIG. 2.

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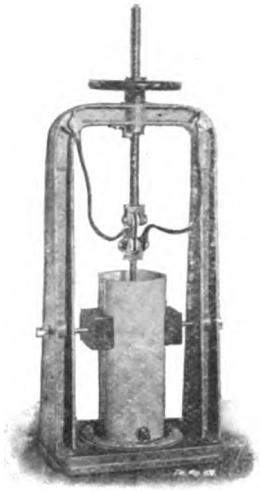


FIG. 3.

A film of oil is sometimes kept on the top of the water to retard evaporation.

The temperature variation of resistances of liquids is much higher than resistance metals, as is shown by the following :

	Specific Resistance at 15° C. = (ohms per cm. × 10^9).	Change of resistance % for a rise of 1° C. at 15° C.
Platinoid consisting of 50 % Cu, 24 % Ni, 24 % Zn, 2 % Tungsten	41,900	.031 %
Iron	10,600	.48 „
Carbon	4,000,000	.026 „
Dilute Sulphuric Acid (1 part acid, 12 parts water)	3,300 000,000	1.5 „
Sulphate of Zinc (saturated solution at 15° C.)	50,000,000,000	2.3 „

For testing purposes water resistances are almost always used. For an alternator giving, say, 2,200 volts, 120 amperes, the apparatus required would be as follows :

(*a*) Twenty barrels about 3 ft. 6 in. high by 2 ft. 6 in. diameter, arranged in two rows of ten each.

(*b*) Four planks 16 ft. long by about 9 in. by 3 in. cross section, these being for the barrels to rest upon.

(*c*) Twenty-four heavy brown-ware insulators, say 5 in. high. These are placed directly on the ground, perfectly hard clay or rammed cinders.

(*d*) Eighteen pieces of sheet-iron 6 in. wide by $\frac{1}{8}$ in. thick, long, overall.

(*e*) Four pieces of sheet-iron 6 in. wide by $\frac{1}{2}$ in. thick and long overall, fitted with

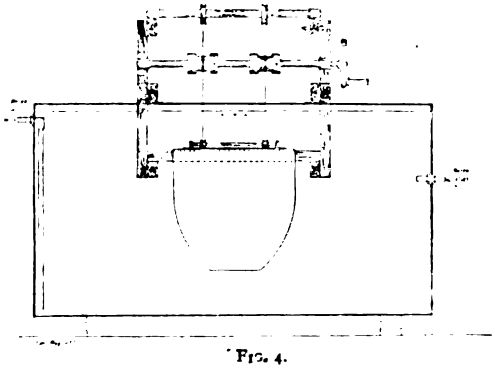


FIG. 4.

wood blocks to rest on and bolts to make connection to main cable.

(*f*) Each of the eighteen pieces to be fitted with a length of window cord passed over a pulley immediately overhead, and the end carried round an ordinary double hitching hook, so that the immersion of the plates can be regulated to a great degree of nicety.

(*g*) Two parallel wooden beams about 4 in. square running immediately over the centre of the hole and about 4 ft. above them. The rope pulleys to be screwed into this rail.

(*h*) Two garden hose pipes with the brass nozzle removed, and even then the attendant must replenish the water in the tubs, by directing the stream from an insulated platform.

The objection to these tubs for testing is that they take up so much room. A cheap and effective way, if a good supply of cool water is obtainable, is to place a metallic resistance in water, and allow a supply of water to run through so as to keep down the temperature of the metallic wire. The current-carrying power of a

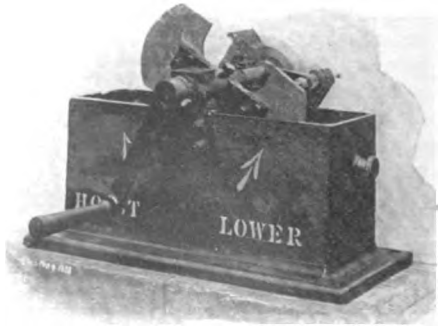


FIG. 5.

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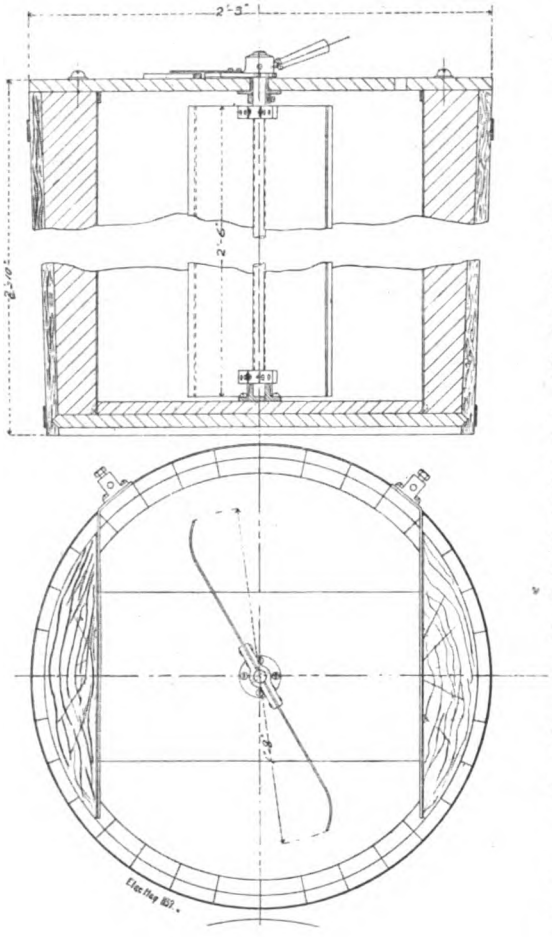


FIG. 6.

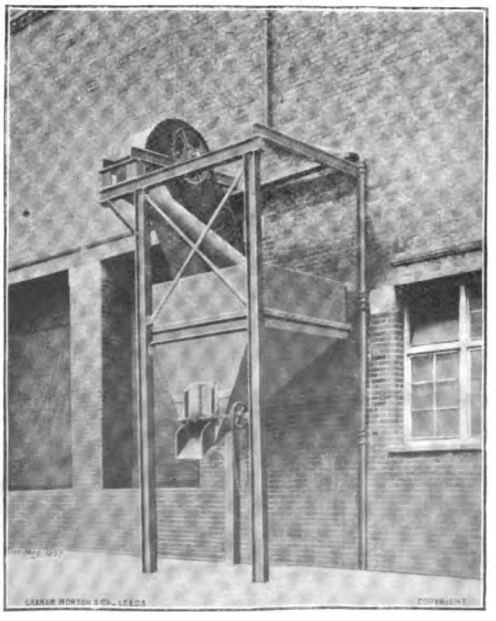
metallic conductor in a water bath is almost unlimited, and the resistance can be regulated by regulating the supply of water.

M. Weber, of Nancy, has used a testing apparatus consisting of six lengths of iron wire .128 in. diameter, and 65 yards long. Wound into coils and placed side by side in parallel in a wooden box with 27 gallons of cold water per minute passing through the box, the wire dealt with no less than 1,660 amperes at 500 volts, that is at the rate of 25,300 amperes per square inch. It carried it for five hours without any signs of deterioration. For testing plant after erection an arrangement such as this is more convenient than tubs, and it is also easy to vary by regulating the water passing through.

Lowering the Cost of Production in Central Stations.

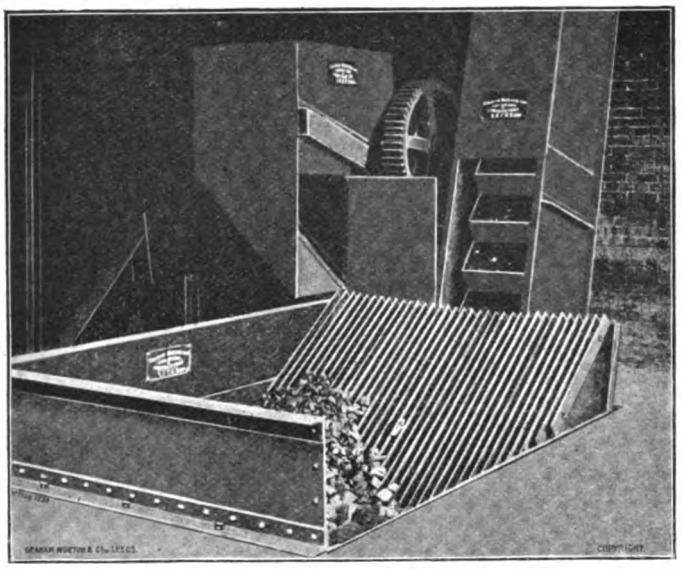
By JAMES CASSIDY, M.I.S.A.

THE last few years have seen remarkable changes in the attitude of the business men of the old country. They are not only awake, but wide-awake, so wide-awake that it is possible for no less an authority than Sir William Ramsay, who has been investigating American methods on the spot, to write a letter to the "New York Times," in which he asserts that American business men are too slow to take advantage of the recent discoveries of science. Most of them, he says, seem ignorant of the latest trend of scientific thought, and English manufacturers are, in scientific detail, far ahead of the American. We could wish that he had not felt it incumbent to add that Germany shows a clean pair of heels to both!—There is, however, one thing that foreign competition would seem to teach, and it is that, economically considered, the fittest for its purpose is the best, and that which is most fit for its intended purpose and which will return in useful service the greatest percentage for the work



ASH ELEVATOR AND BUNKER.

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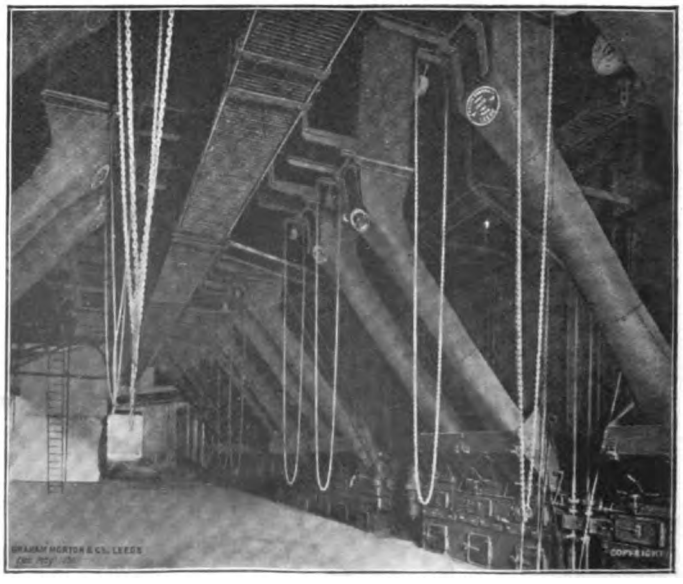


SCREEN HOPPER.

put into it. Possibly the signs of the times would seem to intimate that the markets of the world will revert to the most successful exponents of this theory. But we now leave theories for a brief consideration of some actual designs for the carrying out of practical work under various corporations and private companies in connection with the installation of labour-saving machinery in the electric light and power generating stations of this country.

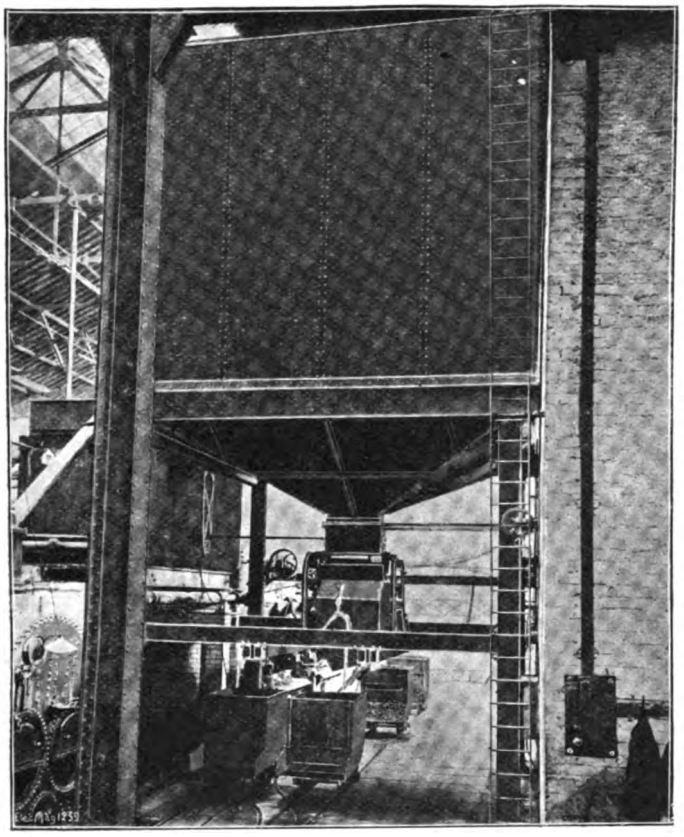
It is quite impossible to even touch on many of these designs for coal and ash-handling installations, so numerous are they; we propose, therefore, to briefly describe a few as typical of the whole. A scheme drawn out for an electric tramways station for a complete coal-handling plant, which should dispense with manual labour, is described herewith. The plant consists of a screen hopper, on to which the coal from the trucks or carts is tipped. Beneath the hopper is a Graham's automatic feed to deliver the coal with regularity from the hopper into the elevator boot. From the boot the coal is elevated by a 15 in. elevator. From the elevator the coal passes down a shoot situated at the head, on to a 15 in. pushplate conveyor. The pushplate is arranged to automatically fill the storage tanks, there being one to each boiler, and each tank is provided with two outlets. At convenient points outlets with long hopper spouts are placed to permit the convenient filling of the coal stores. The bunkers for receiving the store of coal are supplied on the underside with swivelling shoots and a weighing machine is attached to each shoot. The bunkers are supported on girders built into the wall on one side and supported at the other with vertical steel joist pillars.

As the ash leaves the furnace it passes on to a tray-conveyor built into the floor beneath, and provided with hoppers, one to each boiler. The conveyor and



COAL MEASURING CHAMBERS AND CHUTES.

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COAL WEIGHING AND STORAGE PLANT.

its pit are covered over with chequer plates. At the end of the tray-conveyor is a continuous bucket elevator, which receives the ash from the conveyor and delivers it into a storage hopper supported on girders and constructed and held in position in a similar manner to the bunkers already described.

A second very interesting and extensive plant is that designed for a London electric lighting company. The storage bunker and shoots, mechanical stokers, and all the necessary structure for supporting the entire plant, and the gantry running the length of the push-plate conveyor, and all the necessary gearing for driving the machinery, are covered by the contract. The ash-conveying and elevating plant is also similar to that above referred to, and consists of one tray conveyor, seven hoppers under the boilers, for conveying the ash on to the tray conveyor, another hopper at the end of the tray conveyor, with a flap door feed to the elevator; one continuous bucket conveyor, one storage hopper, together with its structures, levers, and slides complete, and all the gearing for the driving of the plant as in the case of the coal-handling apparatus. Appended is a table showing the cost of operating similar coal-handling plant to that described and illustrated above. The figures are significant enough, and indicate at what a marked disadvantage the station without coal-handling plant is. The reader can easily gather from the views accompanying this short article the general character and design of coal and ash-handling machinery, without it being necessary to enter into extensive and uninteresting details. The cost of working is based on the following:

ESTIMATED COST OF WORKING FOR ONE YEAR.

	£	s.	d.
At 5 per cent. interest on £1500 cost of plant	75	0	0
Depreciation, twenty years' purchase, repairs, maintenance, &c., and renewals 5 per cent. per year	75	0	0
Operation, two men at £1 4s 5d. per week for fifty weeks	120	0	0
Power, 15 h.p. for ten hours daily at 3d. per B.H.P. per hour	56	0	0
Total costs for one year	326	0	0
Cost per day of plant capable of handling 200 tons of coal per day	1	0	2
Total cost per ton, 1.302d., or	0	0	1⅓

Compare this with the cost of handling material by manual labour, which may be estimated under favourable conditions at 6d. per ton.

To Mains Engineers.

We have several articles on cable work, jointing and distribution to appear. Obtain next few issues and read them.

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Electrical artisans should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles on subjects of importance to themselves.

The Ownership of Inventions.

By STUART A. CURZON



A CASE at Worship Street Police Court brings up again the question as to who is the rightful possessor of a workman's invention—master or man. The law at present seems to uphold the master's view of "you-are-mine-body-and-soul." This is not only grossly unfair, but is a direct brake on the wheels of progress as far as it is represented by the inventive genius of the mechanic. A man may be employed at, say, 50s. a week to perform certain duties, which, as a general rule, are carefully defined. To any ordinary mind it is a case of goods bought and delivered—the wage paid being the price for certain services. But it is not so. In many cases it will be found that you are committed to hand over your brains to your master. Presuming that we have an intelligent individual at work, it may happen that in the course of his employment new ideas occur to him—either as a means of gaining greater efficiency or a saving of labour costs. Now the whole of the scheming may have been carried out by the man at home in his own time and at his own expense and many hours of hard toil and careful planning have been necessary before the desired end could be attained. Yet the interpreters of the law lay it down that if the production is of the same nature as that used in his employment then it becomes *ipso facto* the property of the employer. It also appears that should the man make any sort of a drawing while at the shop—perhaps in the dinner-hour—he must not remove it from his employer's premises under pain of being prosecuted for theft.

It is not only unjust, but hits back again on the trade in general. That a man by his own thought and ability should produce an invention, worth, perhaps, thousands of pounds, only to see the fruits of his labours plucked by some unscrupulous employer—probably incapable of designing anything—must appeal to every one as unfair. The man's only recompense is the weekly wage paid to him and for which other value is given.

That some firms will act fairly with those men who produce anything new is admitted, but it is an unfair thing to them even that all are not compelled to do so. A man will not put himself out of the way to produce novel appliances unless he is sure of some recompense. Therefore, the spirit of progress is arrested.

The doctrine that an employer purchases a man's ideas when engaging him as a servant should be exploded. Another method—perhaps not quite so evil—is the adoption of the "suggestion box." Such a box is placed in a conspicuous position in large works, and suggestions are invited from the men. Every month, perhaps, a premium of £1 is paid for the best idea received. Take that there is only one useful idea in twelve months. The firm have laid out £12 in that time in prize-money and have, maybe, secured an invention worth thousands of pounds, and which will materially add to the profits of the firm for many years.

Where there is any doubt in the employer's mind, he secures this most

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undesirable end in many ways. A not uncommon one is to obtain the workman's signature to a form whereby he agrees to be bound by the rules of the firm. The man wants a berth and it does not look unreasonable, so he signs it. Afterwards, perhaps, a printed list of rules is given him. In so far as they apply to his working conditions, he reads them, and when he comes to the inventions clause probably treats it as extraneous matter and does not read it.

The " suggestion box " system is usually covered by the notice on it to the effect that a monthly reward is given, but " Messrs. Blank and Dash reserve the right to adopt any suggestions made."

In most American shops very different treatment is meted out to the men. A mechanic with an idea is invited to communicate the same to his employers. Should it appear to have any commercial value, time, materials, and assistance are placed at his disposal, and he sets to work to produce his invention. Satisfactory terms are made, mostly based on results. There are a few firms in England that adopt yet another system. Any production must be offered to them at a price. Should they refuse to deal, then the inventor is at liberty to sell elsewhere provided he does not offer better terms than those quoted to his employers. Against this little can be said, unless a period for the employers' decision is of too long a duration.

It behoves those mechanics who are of an inventive turn to take particular care as to how they stand in relation to their employers in this matter.

WIREMEN'S SECTION.

Conducted by STUART A. CURZON.

Notes.

THE exhibition fever seems to be contagious. Electrical displays are now the order of the day, and many new appliances are being brought to the front through them. As any means of calling popular attention to electrical devices means more work, we can only hope that they will continue to spring up all round the country. These affairs promoted by the supply companies are much more to our advantage than ordinary trade exhibitions, as they attract the consumer, while the latter merely aim at the contractor.

Wiremen should not miss these displays, as they will find many things new and of great interest which they might not see in the ordinary way.

There seems to be a plethora of arc lamps, and as a number of these are quite new in their mechanism an hour or two spent at these exhibitions would not be wasted, if for this line alone.

Have you ever given attention to the failure of many belt compounds to give satisfaction when used as a preventative to slipping? There is also a certain amount of transmission loss with some that are exceptionally adhesive.

Try instead this method. Get some good hard drying paint or enamel and coat the face of the pulley. The belt, if at all flexible, will then grip all right, and it lasts longer than you would think.

The Electrical Trades Union is the father of a new periodical, with the euphonious name of *Eltradion*. If this is used as a means of educating the members of the Society to higher things in the trade it is welcome. That the paper will be used as a method of increasing the membership of the Society is undoubted. The question is—will it do so? For some reason or other the greater number of electrical workers do not belong to the Union.

This is rather a deep question, and one that requires a lot of thinking about to find an answer. The Union rate of wages is absurdly low, and an increased membership would open the way for the Society to raise the wage limit. But even now large numbers of men are ready to accept wages below the standard 9½*d*. Are there too many wiremen?

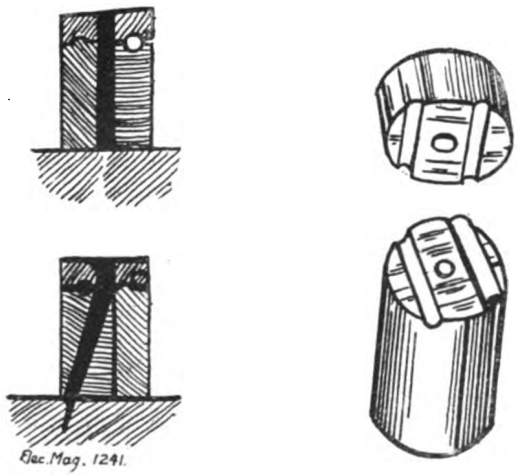
Now is the day of motor traction. At present petrol is having it all to itself. But even there electric ignition is essential

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either by means of magnetos or accumulators—both high and low tension. Wiremen might do worse than look this up and study the peculiarities of the various methods, and the use of sparking plugs. At present they are handled by motor fitters with just a surface knowledge of their functions.

When doctoring up old motors or generators, the following may be useful to remember. For carbon brushes the size should be worked out on a basis of 40 amperes to the square inch of contact surface. The pressure of the brushes on the commutator should be 2½ lbs. per square inch of contact surface.

A rough sketch is shown here of a cleat that may be useful when running



Views of Cleat.

temporary or unprotected wires. By making the hole in the cap sufficiently large and well counter-sinking same, the fixing screw can be put in at an angle where desired. By easing the under edge on one side of the cap, it will slant to take size of wire on the other side.

An interesting case has just been heard at the Staffordshire Assizes. An overhead wire broke and was left hanging for some time. A man not noticing it walked against it and was severely burnt. The point was that the break was caused by undue strain on the bridle wire, according to the plaintiff's case. The defendant company attributed it to arcing caused by an abnormally heavy laden atmosphere.

Those who have worked on this sort of thing could probably give a better explanation. The carbonising and oxidising that always takes place together with an accumulation of gritty particles will speedily cause an arc, and constant inspection and cleaning would be found profitable by tramway authorities. At present it is usually much neglected.

In the course of the case referred to above, counsel said that he "was *afraid* they would all learn something about overhead wires before long." The learned gentleman also remarked that eventually all *overhead* wires would be underground.

The Board of Trade have lately become more strict in connection with motor circuits at 400 volts pressure or above. It would be as well, therefore, if the following extracts from the latest rules issued were noted :

(1) The frame and shaft of every electric motor intended to be worked at above pressure shall be efficiently connected with earth.

(2) The electric lines forming the connections to motors, or otherwise in connection with the supply, and placed upon the premises of the consumer, shall be, as far as practicable, completely enclosed in strong metal casing efficiently connected to earth.

(3) The supply to every motor shall be controlled by means of an efficient cut-off switch, placed in such a position as to be easily handled by the person in charge of the motor, and connected so that by its means all pressure can be cut off from the motor itself, and from any regulating switch resistance or other device in connection therewith.

Efficient fuses, or other automatic cut-outs, shall also be provided, so as to protect the branch circuit on each side of every motor from excess of current.

The above-mentioned switches and cut-outs shall be so enclosed and protected that there shall be no danger of any shock being obtained

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in the ordinary handling thereof, or of any fire being caused by their normal or abnormal action.

(4) A notice shall be fixed in a conspicuous position at every motor and switchboard in connection with the supply forbidding unauthorised persons to touch motors or apparatus.

The Board of Trade reserve the right to revoke their approval if the regulations are not complied with.

Everything should be earthed by means of an iron plate buried in soft earth. The earth wire should be not less than seven-sixteenths galvanised iron wire.

PROBLEM IN LAMP CONNECTIONS.

The problem given in our February issue seems to have been of considerable interest judging by the large number of replies that have been received. Space does not permit but three of the best solutions, nor the lengthy list of names of those who are correct.

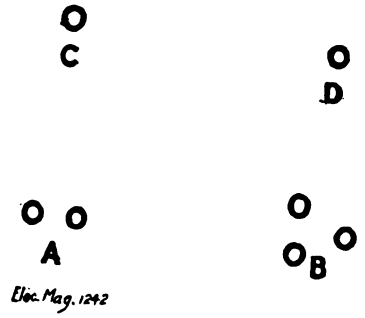
We have received from one of the correct solvers—Mr. C. H. Bowker — another little problem, given below. Further problems will be acceptable, and to the sender of what we consider the best during the next three months a useful prize will be awarded.

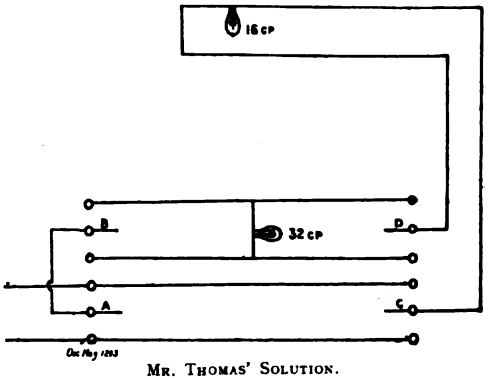
Mr. Bowker's problem is to connect up 2.16 c.p. lamps with an ordinary tumbler switch and a two-way switch so that the following results may be obtained.

(1) Both lamps out;
(2) Both lamps in series;
(3) One lamp in;
(4) Both lamps in.

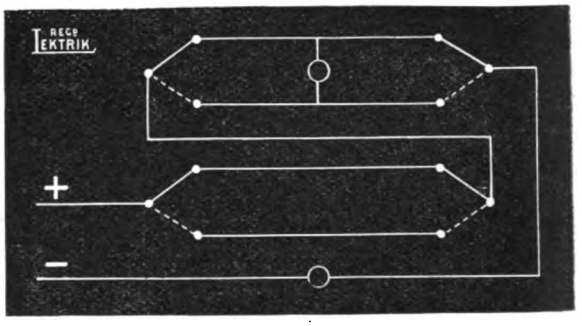
How is it done ?

A represents tumbler switch.
B represents two-way switch.
C and D represent 16-c.p. lamps.

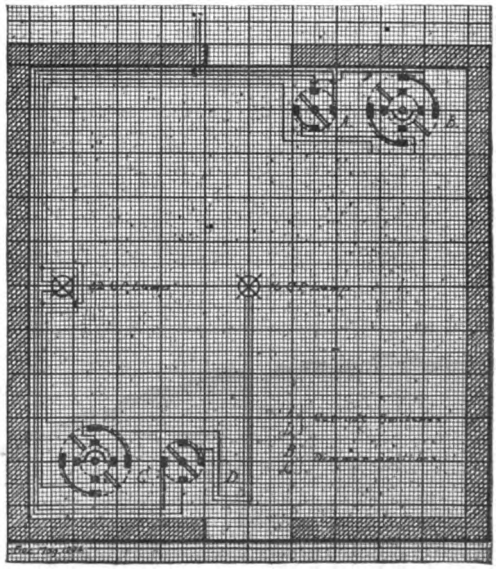




Mr. Thomas' Solution.



Mr. Lundberg's Solution.



Mr. Bindemann's Solution.

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The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects are arranged *under subject-matter* in this section. Suitable references are made to the names and dates of the various papers, and the whole forms an index guide of considerable importance and value.

Power.

Articles.

Electric Power in Factories. A. W. Kershaw.	*Elec. Wrld. & Engr.* 18/3/05.
Individual Motor Drive in a Type Foundry.	*Elec. Wrld. & Engr.* 18/3/05.
*Application of Electric Motors to Machine Tools. G. T. Hanchet.	*Elec. Wrld. & Engr.* 18/3/05.
An Iron Foundry Electrically Driven Plant.	*Elec. Wrld. & Engr.* 18/3/05.
Application of Electricity to a Large Manufacturing Industry.	*Elec. Wrld. & Engr.* 18/3/05.
An Induction Motor Factory Installation.	*Elec. Wrld. & Engr.* 18/3/05.
Electric Power Equipment of a Modern Machine Shop.	*Elec. Wrld. & Engr.* 18/3/05.
Variable-Speed Motor Equipment of a Motor Factory.	*Elec. Wrld. & Engr.* 18/3/05.
*Electric Motor Equipment of the Worthington Hydraulic Works.	*Elec. Wrld. & Engr.* 18/3/05.
Power Plant at Olympia, Washington.	*Strt. Rly. Jrnl.* 11/3/05.
An Important Italian Hydro-Electric Installation. E. Bignami.	*Elec. Rev. N.Y.* 11/3/05.
Proposed Central Power Station at Washington.	*Elec. Rev. N.Y.* 11/3/05.
Electricity in Agriculture. E. L. Durand.	*Elec. Rev. N.Y.* 11/3/05.
*Oil Insulated *v.* Air Blast Transformers. M. A. Sammett.	*Elec. Rev. N.Y.* 11/3/05.
Use of Coke Oven Gas in Gas-Engines.	*Power, March*/05.
Blast Furnace Gas-Engines at the Ilseder Ironworks. E. Guarini.	*Power, March*/05.
*Commercial Possibilities of Blast Furnace Gas for the Development of Electric Power. F. P. Thomson.	*Elec. Chem. Ind. March*/05.
*Variable Speed Motors. (X.) W. Baxter.	*Machy. N.Y. March*/05.
Impulse and Reaction Turbines.	*Machy. N.Y. March*/05.
Electric Motor Drive in a Naval Gun Factory.	*Machy. N.Y. March*/05.
Hydro-Electric Plant at Janesville. P. J. Kelly.	*West. Electn.* 4/3/05.
Power Generation and Distribution for Forligno, Italy. F. Koester.	*West. Electn.* 11/3/05.
Plant of the Brooklyn Institution of Arts and Sciences. E. T. Walsh.	*Amer. Electn. March*/05.
Electrical Equipment of Messrs. Harland and Woolf's Shipbuilding Works.	*Electn.* 31/3/05.
Steam Turbines. Their Application from an Electrical Standpoint. Munch.	*L'Eclair Elec.* 4, 11, 18/3/05.
Quednau Electric Farm. E. Guarini..	*L'Eclair Elec.* 4/3/05.
Hydro-electric Installation at Gromo, Italy. (Serial.) De Kermond.	*L'Electn.* 4/3/05.

Papers.

Use of Electrical Energy in Mines and Collieries. M. B. Mountain	*Manch. I.E.E.* 28/3/05.
Electrical Cranes. Mr. Jennison.	*Manch. I.E.E.* 7/4/05.
Lightning Conductors. W. H. Whitehouse.	*Birm. Elec. Club,* 8/4/05.
*Unsolved Problems in Electrical Engineering. R. E. C. Crompton.	*Inst. C.E.* 10/4/05.

Traction.

Articles.

Electrification of the London Underground Electric Railways System. S. B. Fortenbaugh.	*Strt. Rly. Jrnl.* 4/3/05.
Electrical Equipment of the New Steel Cars for the New York Subway. L. B. Stillwell.	*Strt. Rly. Jrnl.* 4/3/05.
*Car Wheels: A Study of Their Costs. D. F. Carver.	*Strt. Rly. Jrnl.* 11/3/05.
*Creating Traffic. E. P. Hulse.	*Strt. Rly. Jrnl.* 11, 18,25/3/05.
Amusements for Park Resorts.	*Strt. Rly. Jrnl.* 11/3/05.
*Increasing the Capacity and Reducing the Noise of the Union Elevated Railroad of Chicago. Report by B. J. Arnold.	*Strt. Rly. Jrnl* 18/3/05.
Recent Work of the Electric Railway Test Commission.	*Strt. Rly. Jrnl.* 25/3/05.
*Fuses *v.* Circuit Breakers for the Protection of Railway Apparatus. E. Taylor.	*Strt. Rly. Jrnl.* 25/3/05.
*Opening of the Bloomington, Pontiac, and Joliet Single-Phase Railway.	*Strt. Rly. Jrnl.* 25/3/05.
Railway Signal Systems. A. Ames (jun.).	*Elec. Rev. N.Y.* 4/3/05.
Development of Automatic Couplers for Electric Cars. W. T. Van Dorn.	*Strt. Rly. Jrnl.* 15/2/05.
Wear of Steel Tyred Wheels. W. G. Price.	*Strt. Rly. Jrnl.* 15/2/05.
*Cost of Locomotive Operation. G. R. Anderson.	*Rlrd. Gaz.* 17/3/05.
Manganese Steel Rails on the Boston Elevated.	*Rlrd. Gaz.* 17/3/05.
New Locomotives on the Valtellina Railway.	*Elec. Engr.* 24/3/05.
*The Future of Railways. P. Dawson.	*Elec. Rev.* 24/3/05.
Electric Installations of the Paris-Juvisy Line. Bourguignon.	*L'Eclair Elec.* 30/3/05.

Papers.

The Future of Electric Automobile. T. G. Chambers.	*Auto. Club,* 16/3/05.

Lighting and Heating.

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Car Lighting and Ventilation. J. P. Fox.	*Strt. Rly. Jrnl.* 25/3/05.
The Largest Municipal Electric Plant in New England. A. D. Adams.	*Elec. Rev. N.Y.* 4/3/05.
Some Electric Lighting Troubles which Might Be Avoided. A. H. Moyes.	*Elec. Engr.* 3/3/05.
The Lietner-Lucas System of Electric Train Lighting.	*Elec. Rev.* 17/3/05.
Variations During One Period of the Luminous Flux Emitted by a Voltaic Arc Fed by Alternate Current. Leonard.	*L'Eclair Elec.* 4/3/05.
Electric Lighting of Trains. Valbreuze.	*L'Eclair Elec.* 11, 18/3/05.
The Future Paris Electric *Regime.* Blondin	*La Rev. Elec.* 15/3/05.
The Tantalum Lamp. Grunzweig.	*L'Electn.* 18, 25/3/05.

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Papers.

Twenty-five Years of the Incandescent Lamp. J. T. Marshall.	*Franklyn Inst.* 16/3/05
On the Flux of Light from the Electric Arc of the Varying Power Supply. J. A. Fleming.	*Phys. Soc.* 24/3/05.

Telegraphy and Telephony.

Articles.

Report of Directors of the New York and New Jersey Telephone Company.	*Elec. Rev. N.Y.* 4/3/05.
*Telephone Engineering. (XIV.) J. C. Kelsey.	*Elec. Rev. N.Y.* 11/3/05.
Rural Telephone Line Building. L. W. Lee.	*Sound Waves, March/05*
Railway Composite Systems. G. W. Wilder.	*Sound Waves. March/05.*
Line Testing. G. J. Newton.	*Sound Waves, March/05.*
More Noisy Line Talk. J. C. Kelsey.	*Sound Waves, March/05.*
Importance of Competent Exchange Management. C. Russell.	*Sound Waves, March/05.*
*Telephone Construction Practice. H. J. Menhinnick.	*Telephony, March/05.*
*Bankers Buying Up Independent Securities. W. Glendinin.	*Telephony, March/05.*
Simultaneous Telephony and Telegraphy. C. A. Stone.	*Telephony, March/05.*
Concerning Telephone Switchboards. S. G. McMeen.	*Telephony, March/05.*
The Question of Rapid Telegraphy. C. A. Randall.	*Telephony, March/05.*
The Automatic Problem. A. Kneisel.	*Telephony, March/05*
Telephone Line Engineering. C. J. H. Woodbury.	*Telephony, March/05.*
Eliminating Isolation from Farm Life. F. Deland.	*Telephony, March/05.*
*Modern Telephony in Theory and Practice. W. H. Radcliffe.	*Teleg. Mag. March/05.*
Insect Menaces Lead-covered Cables. F. E. Dwight.	*Teleg. Mag. March/05.*
The Barretter: Aid to Long-Distance Telephony. E. C. Long.	*Teleg. Mag. March/05.*
Fessenden's Selective Space-telegraph Apparatus.	*West Electn.* 18/3/05.
Automatic Block Signals. R. Scott.	*Amer. Electn. March/05.*
The Telephone Sub-station and Its Connection to the Central Office. A. O'Brien.	*Amer. Electn. March/05.*
The Steljes Telegraph System. Poncelet.	*L'Electn.* 11, 18, 25/3/05.
On Electrolytic Wave Detectors. Valbreuze.	*L'Eclair Elec.* 25/3/05.

Papers.

*Interference in Wireless Telegraphy. J. S. Stone.	*Can. Soc. Civ. Engr.* 9/3/05.
Generator Call Lamp Line Board. O. Knell.	*Iowa Tel. Soc.* 15/3/05.
The Relation that Should Exist between the Farmers' Mutual and Their Independent Companies. C. A. Hollis.	*Iowa Tel. Soc.* 15/3/05.
Magneto Multiple *v.* Central Energy Multiple Boards, for Small or Medium-Sized Exchanges. J. M. Plaster and R. S. Reedman.	*Iowa Tel. Soc.* 15/3/05.
The Development of Toll Business and Checking of Tolls. J. H. Shoemaker.	*Iowa Tel. Soc.* 15/3/05.
Recent Advances in Wireless Telegraphy. G. Marconi.	*Royal Inst.* 3/3/05.
Telephony. W. L. Webb.	*Soc. Arts*, 27/3/05.

Electro-Chemistry.

Articles.

Electric Purification of Water. P. Hartenfels.	*Power, March/05.*
Electro-chemical Reactions in Solid Electrolytes. F. Haber and H. Tollozzjo.	*Elec. Chem. Ind. March/05.*
A System of Classification for Electrochemical Bibliography. A. L. Voege.	*Elec. Chem. Ind. March/05.*

Electro-Physics.

Articles.

*Transfusion (Electrical). A Study of the Theory of Physiological Experiments and Therapeutical Application of Curative Agents Through the Tissues by Static Electricity. J. J. Edmondson.	*Elec. Rev. N.Y.* 11/3/05.
On Insulation Testing. Revilliod.	*L'Eclair Elec.* 11/3/05.

Papers.

Direct Reading Resistance Thermometers. A Campbell	*Phys. Soc.* 10/3/05
*Report on the International Electrical Congress at St. Louis. W. Dudell	*Inst. E.E.* 6/4/05.
Determination of the Moment of Inertia of the Magneto Used in the Measurement of the Horizontal Component of the Earth's Field. W. Watson.	*Phys. Soc.* 14/4/05.
Note on the Voltage Ratios of an Inverted Rotary Converter. W. C. Clinton.	*Phys. Soc.* 24/3/05.
*A Pertinacious Current. Sir O. Lodge.	*Royal Inst.* 24/3/05.

Electro-Metallurgy.

Articles.

Metallurgical Calculations. J. W. Richards.	*Elec Chem. Ind. March/05.*
Equipment of a Laboratory for a Smelting Plant. H. Haas.	*Elec. Chem. Ind. March/05.*

Papers.

Electrically Heated Carbon Tube Furnace. R. S. Hutton and W. S. Patterson.	*Faraday Soc.* 4/4/05.

Manufacturers.

Articles.

Notes on Band Brake Designs. C. F. Blake.	*Machinery, N.Y. March/05.*
Some Faults of Indexing. L. Allen.	*Machinery, N.Y. March/05.*
Drafting Room Practice. R. E. Flanders.	*Machinery, N.Y. March/05.*
*Armature Windings of the Closed Circuit Type W. Cramp.	*Elec. Engr.* 3, 10, 17, 24, 31/3/05.
Bi-Metallic Rheostats. F. Punga.	*Elec. Rev.* 31/3/05.
Pre-Determination of Solenoid Characteristics. P. C. Percy.	*Amer. Electn. March/05.*
Alternate Current Laboratory Testing. G. H. Rowe.	*Jrn. Elec. Pow. Gas, March/05.*
Notes on the Compensated Monophase Shunt Motor. Béthened.	*L'Eclair Elec.* 4/3/05.
Cables for Industrial Currents.	*L'Electn.* 4/3/05.
Electric Energy Meter: Aron System. Aliamet.	*L'Electn.* 11/3/05.
Application of the Different Methods for Determining the Drop in Alternators. L. Druebert.	*L'Eclair Elec.* 18, 25/3/05.
Independent Clocks Electrically Wound. Montpellier.	*L'Electn.* 18/3/05.
Monophase Traction Motors.	*L'Electn.* 25/3/05.

Papers.

Eddy-current Brake for Motor Testing. D. K. Morris and G. A. Lister.	*Birm. I.E.E.* 12/4/05.
High-Tension Monophase Distributing Systems. Brylinoki.	*Bull. Sc. la Soc. des Electns.*
Notes on the Form of the Tension Curves Before and After Transformation. David.	*Bull. de la Soc. des Electns.*

Students.

Articles.

The Closing of Cooper's Hill College. R. Appleyard.	*Elec. Rev.* 17/3/05.

Papers.

Practical Science as a Branch of Education. L. Cumming.	*Rugby Engr. Soc.* 16/3/05.
Some Notes on Modern High-Pressure Switch Gear. C. K. St. John.	*Manch. I.E.E. Stdts.* 17/3/05.

Central Station Practice.

Articles.

Power House Fuel Supply.	*Elec. Rev. N.Y.* 18/3/05.
Difficulty with a Commutator. S. S. Seyfert.	*Elec. Rev. N.Y.* 25/3/05.
Possibilities of the Small Central Station.	*Elec. Rev. N.Y.* 25/3/05.
Bricketted Fuels, Foreign and Domestic. G. M. Randall.	*Power, March/05.*
*Rope Driving. C. Boysen.	*Power, March/05.*
Cylinder Dimensions and Engine Economy. S. H. Bunnell.	*Power, March/05.*
An Unusual Power Station Trouble. L. H. Pyke.	*Power, March/05.*
Taxation Property of Gas and Electric Companies.	*Power, March/05.*
Piping and Power Station Systems. W. L. Morris.	*Strt. Rly. Rev.* 15/2/05.

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Distance Control Switches and Their Lay-Out in Stations.	*Elec. Engr.* 17/3/05.
Electricity Meters. C. H. Gerhardi.	*Electn.* 10, 17/3/05.
Chemical Purification of Boiler Feed Water. C. E. Walsh.	*Amer. Electn. March*/05.
Steam Pipes. R.T. Strohm.	*Amer. Electn. March*/05.
Parallel Operation of Dynamos Having Different Characteristics. L. Lyndon.	*Amer. Electn. March*/05.
Diseases of Electrical Machinery. F. B. Crocker and S. S. Wheeler.	*Amer. Electn. March*/05.

Papers.

Cement in Central Station Design. E. B. Clarke.	*Amer. I.E.E.* 23/2/05.
Evaporators. J. Neill.	*N.E.C.Inst. of E. & S.* 25/3/05.

Electrical Work in the Shops.

Articles.

Suggestions Concerning Electrical Apparatus. W. H. Wakeman.	*Power. March*/05.
Electric Wiring and Its Installation.	*Elec. Rev.* 17/3/05.
Design and Construction of Small Dynamos and Motors. C. P. Poole.	*Amer. Electn. March*/05.
Generator Commutator Repairs. A. B. Weekes.	*Amer. Electn. March*/05.

New Catalogues.

POWER.

Dynamos.—MATHER AND PLATT, LTD., Salford Iron Works, Manchester. The third edition of "D" type dynamos is duly to hand. This contains details and prices of machines for small output, that is, from 1–150 kw. The smallest sizes are of the 2-pole type, but the larger machines have four poles. The field yoke in each case comprises a steel casting, the pole pieces being integral with the case. The parts are strictly interchangeable and renewals can quickly be delivered from stock.

Motors.—THE GENERAL ELECTRIC CO., Queen Victoria Street, E.C. Section "P" of this Company's well-known monster catalogue is before us. It deals with "Witton" continuous current motors of the open, semi-enclosed, ventilated, and totally-enclosed types. It opens with an illustrated and detailed specification of these motors, and sets out in tabular form the various sizes with their prices. The edition, which we notice is the seventh, is well printed and enclosed in a handsome blue cover.

Motor Starters.—GIEPEL AND LANGE, Vulcan Works, St. Thomas' Street, S.E. Prospective users of motors will be interested in a catalogue just published by this firm dealing with "Ward-Leonard" rheostats, motor-starters and circuit breakers. The list is fully illustrated with diagrams, drawings, and photographs, and will be found of considerable value to users of electric power. A number of automatic starters and pressure regulators are also described and illustrated. The circuit breakers listed are made for pressures from 100–600 volts, and for maximum, reverse, no-voltage and emergency release.

CENTRAL STATION PRACTICE.

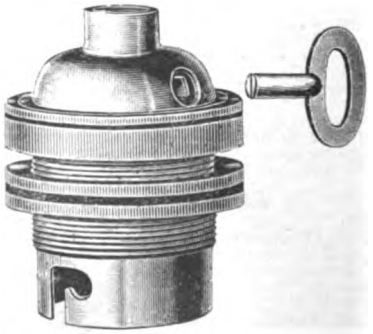
Wiring Conduit.—THE SIMPLEX STEEL CONDUIT CO., Garrison Lane, Birmingham, has sent us the copy of the Simplex Pocket List for 1905. It gives particulars in a nutshell of Simplex fittings and accessories, together with prices of same.

Meters.—THE ELECTRICAL CO., LTD., 122, Charing Cross Road, W.C. We have received list No. 16B describing E.C. Type R.A. ampere hour motor meters. These instruments are fitted with steel ball bearings and they register direct in B.O.T. units on a cyclometer counting dial.

Cables.—THE ELECTRICAL CO., LTD. Sheet No. 11 deals with rubber wires and cables as manufactured by this Company. Full prices and particulars are given.

Induced Draught.—MATTHEWS AND YATES, LTD., Swinton, Manchester. A valuable booklet on induced draught fans has just reached us from this firm. It contains interesting notes on induced draught for steam boilers, and points to their economical value in conjunction with boiler-house plant. Special reference is made to the Cyclone fans, which are the speciality of Messrs. Matthew and Yates. A number of diagrams are included showing various methods of applying the blowers in practice.

Accessories.—THE GENERAL ELECTRIC CO., LTD., Queen Victoria Street, E.C. The "General" Electrical Progress Sheet for February gives particulars of several recently introduced specialities. Amongst these is a portable accumulator with Osmi lamp and also a new tail lamp for motor cycles and cars. The magnet battery fan is described as being very neat and compact. It can be taken apart and folded up into a small space when not in use. A new lamp holder with locking device is another speciality. It has been specially designed to prevent the withdrawal of lamps by unauthorised persons. An illustration of this device is given herewith.



G.E.C. LOCKING LAMP HOLDER.

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The
Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. III. NO. 5. (17th Issue.) LONDON. MAY 23, 1905.

THE RAILWAY MOTOR PROBLEM.

DURING the past month more than ordinary interest has been taken both by electrical institutions and the electrical press in matters bearing directly or indirectly on the subject of main line electric traction. In America and on the Continent electric railway engineers are in the preliminary throes of resuscitating and improving upon the one-phase commutator motor. In both countries practical examples have been constructed and put into operation on short lines, and from these small beginnings the Americans at least are endeavouring to hurry forward equipments of new or converted roads on similar lines. British electrical engineers, although afforded opportunities on the American tour of inspecting the one-phase motors at Pittsburg and Schenectady, and of discussing their merits at the International Electrical Congress, have displayed little or no enthusiasm on the subject. The titles of the papers read before the Institution and its local sections this session give no indication of the existence of any conflicting opinions regarding one-phase motors; in fact, but for the introduction of the subject at a recent meeting of the central body, there would have been nothing to show that one-phase commutator motors for railway work were not looked upon by electrical engineers in this country with the utmost indifference, not to say disdain. Now that we have condescended to bestir ourselves, a faint idea of what we really think of the problem may be extracted from the discussion on the paper in question. Incidentally it transpired at the meeting that the Westinghouse Company had abandoned the Lamme motor and accepted the method of forced compensation adopted by the General Electric Company. Now, we have had so much to do with one-phase currents that we know a little about the early experiments made with a view to perfecting and applying commercially one-phase commutator motors. Our American friends are doubtless as well informed on these topics as we are, but preserve a discreet silence, and convey the impression, with more or less success, that they are doing something new.

Apart from this, however, the question of a standard motor for electric railway work is of the utmost importance, and although early ideas, at one time difficult of embodiment, are now put into practice with perhaps doubtful results, no efforts should be spared to traverse with as little delay as possible the preliminary and unprofitable ground beyond which we are hopeful of achieving something, which, for commercial purposes at any rate, can be called permanently successful. At the present juncture there are numerous excrescenses which require lopping off before the problem is narrowed down to a point admitting of concentrated effort upon the remaining very simple aspect of it. The recent discussions of railway motors and line equipments have, for instance, brought up the three-phase men, who are apparently as zealous as ever. The experiences at Valtellina have been flaunted before us with such additional vigour as two years' successful operation can impart. Mr. Cserhati, of the Ganz Company, has been treating us to additional facts and figures doubtless carefully culled from voluminous

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test data. His arguments are certainly convincing up to a point, and being based on facts, and not figures, can be better appreciated. He seems, however, anxious to force the polyphase system to the front on grounds of economy alone, without regard to simplicity. It seems to us that he overlooks the chief desideratum of main line electric traction, namely, standardisation and simplicity of rolling stock and overhead equipment, conditions which would be difficult to meet with the double trolley. Two overhead wires and two collectors are right enough in the open country on long stretches of road, but they would present enormous difficulties in stations and crowded yards. If it is suggested that local shunting work be done by direct current locomotives the hope of standardisation is at once dashed, and with it goes also that of simplicity. The experience of three-phase railways seems to us to be of too special a character and too isolated a nature to have a direct bearing on the wider aspect of the electric railway problem. Such advantages and economies as it undoubtedly does possess appear to be quite outweighed in the general opinion of electric railway men by the difficulty of the double trolley. The induction motor is mechanically and electrically the ideal machine for railway work, but until it can be applied and operated with one-phase currents we are compelled by conditions which enforce the use of a single conductor to rely on the commutator form of motor for one-phase currents.

Although the work which is at present being done with one-phase commutator motors is practically barren of progressive result there are no signs of a lack of energy on the part of experimenters in this direction, nor is it yet apparent that the limits which might impose further restrictions on the construction of such motors have yet been reached. Mr. A. C. Eborall, in discussing the recent paper read before the Institution, expressed every confidence in the future of the one-phase motor, though he did not scruple to emphasise the restrictions which are at present preventing its wider employment. He thought that the series motor would take precedence of the repulsion motor, but that it would not remain in the form adopted on the American roads recently put into operation. He drew attention to the low voltage at which these motors are operated, an arrangement demanding stepdown transformers and controlling apparatus for heavy currents. For narrow gauge lines he expressed the opinion that the one-phase motor, by reason of the restricted space into which it would have to be crowded, would only be satisfactorily used with forced draught. Mr. Eborall confidently hopes that the development of compensated series motors for stationary industrial purposes will ultimately bring about a solution of the problem of a similar motor for railway purposes. In this latter respect we quite agree with him.

There is some satisfaction in the thought that there is no immediate hurry. Railway men probably want to see how much more they can get out of the steam locomotive before discarding it once and for all. It is for us to make good use of the breathing space thus afforded, and judging by the zeal and energy which are now being devoted to the problem, every spare moment is being well utilised. At the present juncture, however, extreme caution is necessary to avoid jumping at conclusions as to the merits of this motor or that. In some measure we can afford in this country to sit on the fence. In America and on the Continent, geographical and urban conditions are specially suitable to railway experiment, and for this reason it is well that our electrical confrères in those countries are willing to bear the brunt of initial research in an important province. Meantime, while we have every hope and confidence in the result we must take, *cum grano salis*, such information as is vouchsafed to us from time to time on the subject.

Special Electrical Transport Number.

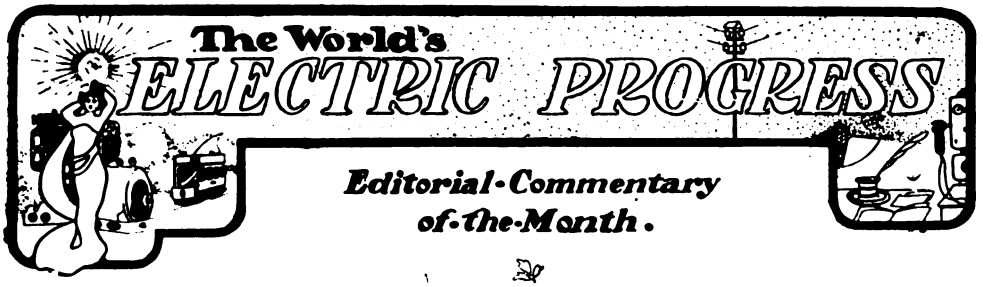
As a Supplement to the ***June issue,*** *we shall publish descriptions of the most modern types of Electrical Transporting Machinery, such as cranes, runways, hoists, lifts, cable ways, elevators and conveyors.*

The matter will be embellished by excellent photographs and drawings, and will be of permanent value to electrical men generally.

If you are interested, order a copy.

If you make any such apparatus, send us particulars and illustrations.

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The Mystery of N-Rays.

THOSE of our readers who are interested in the more subtle electrical phenomena apparently underlying matter will be interested in a series of special articles on the subject of N-rays, which commences in this issue. The author of this series, M. J. Garcin, is able to speak with considerable authority, as he has not only translated from the French the memoirs which Professor R. Blondlot communicated to the Academy of Sciences on the subject of "N" Rays, but he also has extensive personal knowledge of that eminent scientist, and has undertaken a quantity of research work with him. The book to which we refer will be reviewed in our next issue, but at present we wish to specially announce our willingness to supply phosphorescent screens to any of our readers who would like to conduct experiments, and are willing to pay the very small cost of postage. We are publishing the series of articles with a view to making the subject widely known, and in the hope of obtaining valuable data regarding it. Unlike many other discoveries, the presence of N-rays can be observed without expensive physical apparatus, consequently we hope the matter will be taken up and followed by our readers, and the results of their experiments placed on record with us.

Electrical Exhibitions.

IN accordance with our announcement last month we publish as a supplement to this issue an illustrated account of the Paddington Electricity Exhibition, successfully organised by the Metropolitan Electric Supply Company, Ltd. We expatiated last month on the value of exhibitions, and there are not wanting signs from all parts of the country of confidence in such a means of publicity on the part of central station men. At Reading the supply company hit upon the happy idea of opening its Exhibition on Easter Monday. In addition to treating the townsfolk to the delights of basking in the rays of electric lamps, and listening to the fascinating whirr of motors, the supply company threw open the engine room to the inspection of visitors, a privilege which was taken full advantage of and evidently appreciated. The Exhibition was a complete success, and this circumstance is mainly attributable to the enterprise of Mr. A. T. Cooper, who was responsible for the organisation of the arrangements. From Chester we hear that the chief electrical engineer, Mr. S. E. Britton, is taking steps to give increased publicity to the undertaking by the issuance of circulars and by advertisements in the local press. At the same time the Council have approved of his recommendation to open an Electrical Exhibition for about ten days in September next. Loughborough, which has recently started up a new electricity works, opened the ball with an extensive Electrical Exhibition. Several other towns are catching the exhibition fever, among these being Exeter, where the summer months, with their heat and dust, are considered the best time of year to attract attention to the value of electricity for lighting and power purposes. Naturally, they do things differently at Exeter.

Tramways Parcels Departments.

A MOVE in the right direction has been made by several tramway authorities in this country. The enterprise in developing parcels express as a remunerative adjunct to a tramway system is not confined to municipalities, and though not shared in the same numerical extent is

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actively participated in by tramway companies. This new development is but the natural outcome of the existence of a tramway system, more especially when it covers a thickly-populated industrial area. The Manchester Corporation has instituted a parcels service on a very extensive scale. Not only is it possible to obtain the delivery of parcels up to 112lb. weight in the Manchester and Salford district, but by reason of co-operation with the railway companies such packages can be sent to all parts of the country and also abroad. An express messenger service has also been put on for



FREIGHT CAR, MANCHESTER CORPORATION TRAMWAYS.

parcels not exceeding 14lb. in weight, these being conveyed direct to their destinations within half a mile of any of the tram termini or lines of route. The rates fixed include collecting and delivery, and in addition to special freight cars, such as we illustrate, horse-drawn express carts and collecting vans are used. The system has been worked out very closely in detail and the convenience of the public studied in every possible way. For instance, prepaid parcels stamps can be obtained at their face value in quantities of not less than twenty-five. Cash on delivery arrangements have also been made. At Bradford, where a somewhat inadequate parcels service had been bequeathed to the electric tramways from the old steam lines, a highly efficient system, remodelled from previous practice, was put into use at the beginning of this year. Here parcels are also carried from 7lb. to 112lb. weight, and the collecting and delivering area extends for several miles. A motor parcels van is a valuable accessory to the system. Other Corporations operating parcels services are Huddersfield, Burton-on-Trent, Reading, Bury, Halifax, and Ipswich. Among the companies the Dublin United Tramways Company, Ltd., has successfully carried through parcels for many years, and developed the service on profitable lines. After paying all expenses of superintendence, repairs, renewals, &c., for the year ended December 31st, 1904, the profits amounted to nearly £2,800. At Edinburgh, Gravesend, and in the Pottery district the tramway companies all have parcel services.



The New I.E.E. President.

MR. JOHN GAVEY, C.B., has been nominated as President of the Institution of Electrical Engineers for the session 1905-6, and as his election will be confirmed without doubt at the next annual meeting we take this opportunity of extending our congratulations to him, and also of presenting our readers with his portrait and a few biographical notes. Born in 1842, Mr. Gavey, who bears the weight of his years very well, entered the service of the Electric and International Telegraph Company in 1860, after being educated at Victoria College, Jersey. He subsequently occupied positions as superintendent of the South-Eastern Division of England, and superintending engineer of the South Wales District of Telegraphs. At the end of 1892 he became chief technical officer at the London G.P.O., and after two subsequent steps between 1897 and 1902 he succeeded Sir William Preece as Engineer-in-Chief. Space will not permit us lengthy reference to Mr. Gavey's valuable work both in telegraphy and telephony, but this is well known, and, moreover, is highly appreciated. Mr. Gavey's is a familiar figure at the Institution, and his occupation of the vice-presidential, and subsequently of the presidential

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chair, will, we are sure, give general satisfaction. His power of command at the meetings has already been abundantly evident, though at the same time his genial presence at all times begets a feeling of confidence and respect. The highest honour which electrical engineers can confer will rest worthily on Mr. Gavey's shoulders, and under his auspicious guidance we anticipate a successful session for 1905-6.



Photo by [*Elliott & Fry.*

JOHN GAVEY, C.B., PRESIDENT-ELECT OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Lead Covered Cables.

THE very instructive article which Mr. J. H. C. Brooking contributes to the Central Station Practice section this month on the subject of lead-covered cables should be read by all mains engineers. The success or failure of this class of cable depends on two things, the exclusion of moisture and either the bonding and earthing of the sheath or the insulating of it. To successfully keep out moisture complete reliance can be placed on lead sleeves for the joints, these sleeves being plumbed to the lead of the cable on each side of the joints, the whole being then run in solid. From what we are able to gather the iron box with brass glands is not so satisfactory, and wherever it can be, should be, avoided. Of the two methods, earthing or insulating, we prefer the former, as being more simple and more readily applicable to everyday practice.

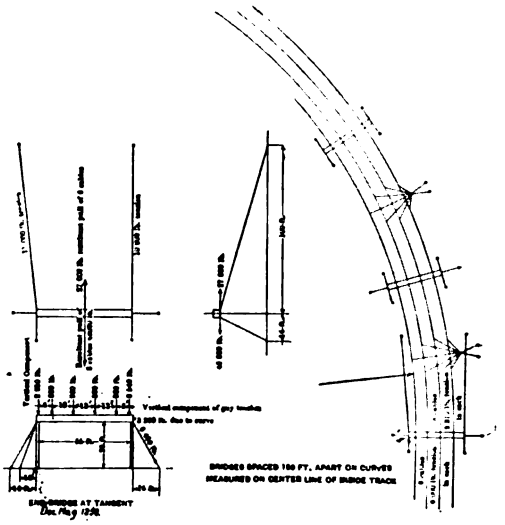
Too much stress cannot be laid on the testing at the maker's works of lead-covered cables, and the hydraulic system to which Mr. Brooking refers has every appearance of being effective and satisfactory. From the customer's point of view it is particularly convenient, as the test can be quickly

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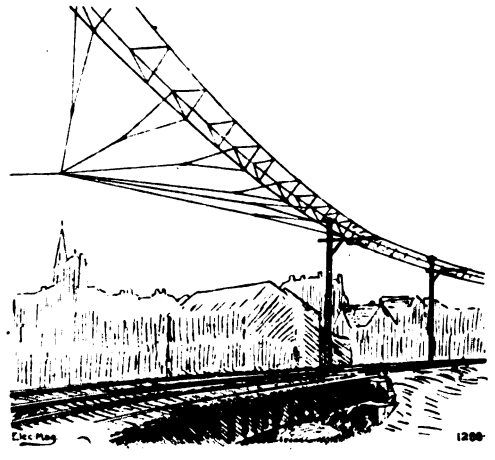
applied, and, moreover, under his direct observation, so that he can depart at least in some measure satisfied. The time is not yet ripe for the standardization of any one method of cable manufacture and laying, but it is of the utmost importance to the electrical industries generally that station engineers having lead-covered cables under their care should adopt either the whole hog lead bonded system or the whole hog lead insulated system mentioned by Mr. Brooking, and steer clear of any happy-go-lucky arrangements, which are bound to bring trouble in time.

H.T. Overhead Traction Equipment.

In our Traction Section this month will be found a lengthy illustrated extract from an important paper recently read before the American Institute of Electrical Engineers. Although one-phase railway motors are still in the transition stage, this circumstance need place no restrictions on the perfection of methods for supplying high potential energy to the trains. There is no doubt whatever about the employment of high voltages for traction work on main lines, and the more speedily the overhead equipment is improved and standardized, the less delay will there be in getting routes converted to electric driving so soon as a suitable motor is available. The particulars laid before the American Institute of Electrical Engineers represent what has been done in practice up to the present time towards obtaining a suitable method of suspension. With the ordinary catenary system employing two messenger wires, illustrations of which on curves are given herewith, there seems to be nothing for it but to use a bold type of collector. Indeed, for high speeds it does not appear that the trolley wheel would be of any service. It will be noticed from the abstract to which we refer above that the compressed air used for braking on the train is applied to the manipulation of the trolley arm. This, of course, is practically a necessity, because all risk to the conductor of contact with the high pressure line must be obviated. The use of frequent supports, steady strains, and tie wires does not improve the appearance of the overhead conductor, but in this case safety must be first considered, and it is only by numerous points of suspension that this can be guaranteed. The Huber collector of the Oerlikon Company is an extremely valuable and effective device, and from the description we publish of it this month it will be noticed that it possesses the all-important property of flexibility. The special method of supporting the overhead conductor necessitated by its use may possibly prevent its becoming generally adopted, but in the present state of the electric railway art it is not safe to predict the future of any device of the kind.



PLAN OF PULL-OFF FOR CATENARY SUSPENSION.



H. T. CATENARY SUSPENSION ON CURVE.

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Wireless Telegraph Litigation.

JUDGING by the recent legal proceedings between the American Marconi Company and the American de Forest Wireless Telegraph Company, the lot of the inventor of wireless telegraph apparatus is very far from being a happy one. Mr. Marconi has always been credited with the invention of the commercial wireless telegraph, and in the recent case by which his American company sought to obtain an injunction against the de Forest Company, his claims to that distinction were in every way borne out by the language of the Court. In his historic pioneer work Marconi was preceded by such men as Dolbear, Popoff, Lodge, and Hertz, all of whom contributed towards the ultimate success of his early efforts. The said prior disclosures and imperfect operation of Marconi's apparatus previous to 1898 or 1899, when modifications and improvements were effected, did not, in the opinion of the Court, deprive the original patent of all claim of novelty, nor in any way prejudice the opinion held of a high exercise of inventive ability by Mr. Marconi.

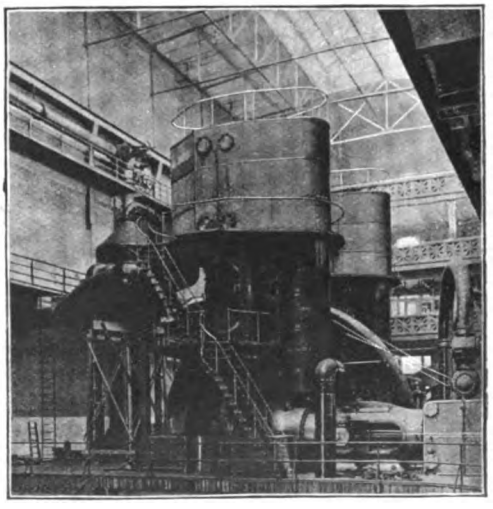
From the opinion handed down by Judge Townsend in the United States Circuit Court, both the Marconi Company and the de Forest Company claim a victory. The latter has succeeded in invalidating claim No. 1 of the patent, as if this had been sustained it would dominate completely the employment of Herzian waves for the communication of intelligence, at the same time the apparatus referred to in claims 3 and 5, upon which the Marconi Company scored, is now very seldom used.

The Marconi Company, in their turn, though failing to score in the matter of forms of imperfect contact, devices have obtained an important and favourable decision in regard to the use of aerial conductors. At the same time, Mr. Marconi has the satisfaction of knowing that his labours in the province of wireless telegraphy are appreciated.



Reciprocating Engines and Steam Turbines.

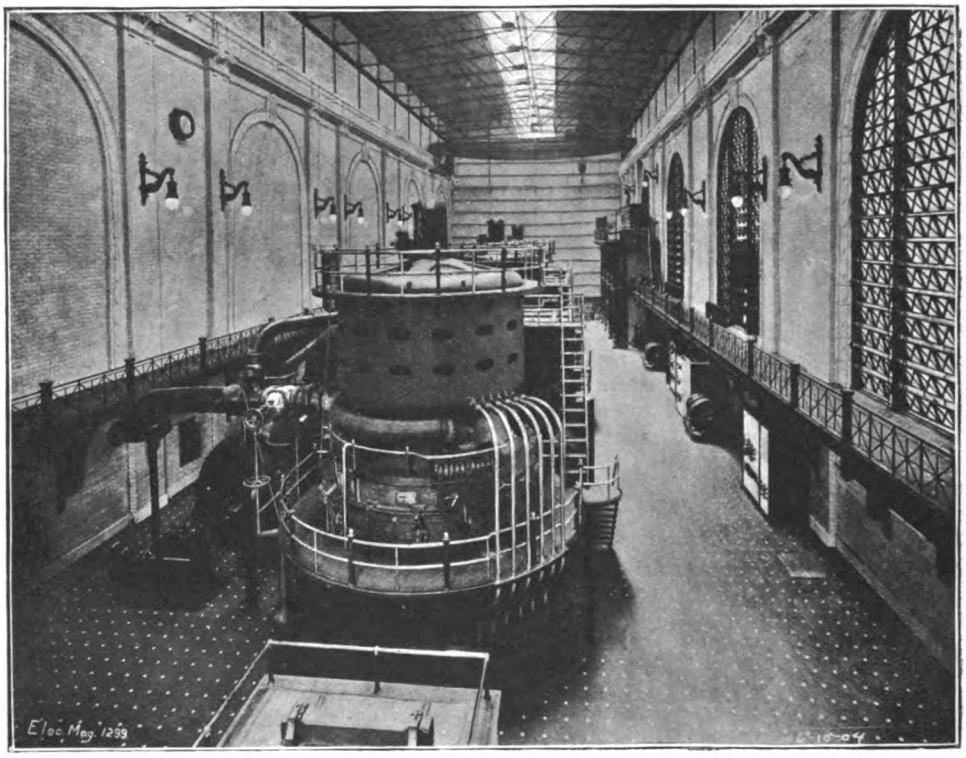
FROM time to time we have drawn attention to the marked differences in floor space occupied by reciprocating engines and steam turbines respectively. An important factor bearing directly upon the introduction of steam turbines into central electricity stations is undoubtedly that of floor area occupied per unit installed. Although doubts are entertained as to the economy and efficiency of the steam turbine from a thermodynamic standpoint there is no room for question as to the saving in foundation space which its use confers. A horizontal Corliss engine of 400 h.p. requires about one square foot per h.p. of space, this figure dropping to 0.75 for an engine of 1500 h.p. output. The vertical engine of the same class, with an output of 1000 h.p., requires 0.4ft. per h.p., a figure which is reduced but slightly—to 0.3ft. per h.p.—for a machine of 4000 h.p. output. In the case of the steam turbine the space occupied



5500 K.W. RECIPROCATING UNIT, PHILADELPHIA ELECTRIC CO.

is very nearly uniform for most sizes, for instance, the 1000 h.p. machine occupies space equal to 0.18ft. per h.p., and a constant figure of 0.1ft. per h.p. is maintained in the sizes of 3000 h.p. and upwards. We give illustrations showing the appearance of 5500 k.w. units in both the reciprocating and turbine types. The first of these is one of a number installed in the alternate current power-house of the Philadelphia Electric Company, and it may be taken as typical of standard American practice with large vertical and horizontal reciprocating engines. Many thousands of horse-power of this class of plant are giving successful service in several large American stations. A striking comparison with the reciprocating unit illustrated above is a generator of

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INTERIOR FISK STREET STATION, CHICAGO. THREE 5500 K.W. TURBO-GENERATORS.

exactly similar output, but of the turbine class, illustrated on this page. This unit is one of three installed in the Fisk Street Station of the Commonwealth Electric Company of Chicago. It is proposed to install fourteen of these units under the one roof of the station as extensions become necessary. The two other sets can be distinguished in the photograph from which also the position of the condensing plant for each machine can be observed. The engine-room containing these generators is only 65ft. wide, and though these narrow limits are in some way accounted for by the absence of switch gear, which is installed in a separate building, they give a very good idea of the exceedingly compact nature of the design. The large turbo-generators put down in this country are all of the horizontal type, so that the parallel drawn above cannot be exactly matched in our own stations. It is nevertheless significant of the importance attached to and the faith reposed in the vertical turbine by American engineers. Within a remarkably short space of time monster units driven by bot'. reciprocating and turbine engines have been built and put into service in the United States, and the experience thus placed at the disposal of British engineers has proved, and is proving, immensely helpful.

An Electric Road Elevator.

THE main portion of the city of Cleveland is located on a level nearly 70ft. higher than that section occupied by the coal yards, lumber yards, and manufac turing plants, which are situated along the Cuyahoga River on the Flats. On account of the great amount of traffic and heavy teaming required from the Flats to the upper level, a long distance has to be traversed through various streets by the wagons and carts, and the loads hauled must be comparatively light on account of the heavy grades. By the installation of the electric road elevator, shown in the accompanying

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ROLLING ROADWAY IN USE AT CLEVELAND, OHIO.

illustration, by the Cleveland Rolling Road Company, the horses, wagons, and other vehicles are able to take the most direct line from the Flats, the rise of 65ft. in about 400ft. being made by means of this mechanism in a few minutes, while previously from half an hour to an hour was required to mount the hill by the roundabout way. The rolling roadway runs on several thousand small wheels, the roadway revolving around a large sheave at the upper end, the returning belt running underneath on idlers, provided for the purpose, to a similar wheel or sheave at the lower end of the incline.

The capacity of the road is about 600 vehicles per day, and the horses, while somewhat surprised, pay little attention, seldom being alarmed, even for the first time. The speed of the road is about three miles per hour, and a number of wagons can be handled at the same time, as the roadway can be started and stopped when desired. The operating mechanism consists of four electric motors placed at intervals along the incline, all of which are operated by a single controller. The vehicles are driven upon the rolling roadway, one at a time, as many as six wagons having been carried up the incline at the same time with loads as high as nine tons, including the horses and wagons, while the time required for the trip is about three minutes, including the stops necessary for the other vehicles to get on and off the rolling road. The cost of transportation of teams up this incline is about ten cents per trip, thus saving a number of times this amount in case the vehicle with a much lighter load was required to take the roundabout way, with the additional wear and tear on the horses and vehicles and the increased time required.

THE WINDMILL.

Operated by DON QUIXOTE.

IV.—Britain's Greatness.

I HAVE been told by a parsonic person that the surest way for a preacher in the West-End to get himself thoroughly well liked is to go for the godlessness of the gilded classes. Let him draw parallels between Society dames and Piccadilly Peris, consign wearers of fur coats to regions where such apparel would be superfluous, and generally devote himself to the production of anathema in bulk, and Rank and Fashion will mob him, recognising how marvellously well the cap fits—someone else in the same set. The reason that no one is offended is that nobody for a moment loses his sublime self-satisfaction. The case-hardening is too deep.

In the same way I am hopeful that the philippic I now propose to write will tend to endear me to all engineers who condescend to read it, for the reason that, to the best of my limited ability, I intend to mop the floor with that myth called British Enterprise. The thought of every reader will at once fly to the shortcomings of someone else; by no chance will he think it applies to his own business methods.

Firstly (a sermon always begins with firstly) let me remark that the emblem of Britain's Greatness is a ramping, ravaging lion. He sticks his fur on end, displays his gory mane to the best advantage, balances himself on the middle toe of one hind foot, and brandishes his tail. He is altogether an interesting sight. He would be awe-inspiring if he were only convincing. Let us now examine a few facts.

The home of the steam locomotive was the North of England. George Stephenson was an apostle of British engineering whose halo shines brightly even in these irreverent days. British capital, British labour

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developed almost to perfection the system of steam railways, and for a long time England was the workshop of the world for steam mechanisms.

Two years ago the Great Western Company put a French express locomotive in competition with our own on British ground, and it beat us. I hear they want more!

The son of the locomotive-maker, Robert Stephenson, was a great bridge-builder. After putting up the Menai Bridge as a curtain-raiser, he crossed the pond and astonished our Canadian cousins with the Victoria Bridge over the St. Lawrence.

Who claims the contracts for the big bridges of the world to-day? We claim the Zambesi; who claims the rest? The lattice and trellis girders, borrowed from the loose, rough timber bridges of the American engineers, were being developed while we rested satisfied with the tubular type. Who erects the sky-scrapers? Who showed us how to put the roof of a building in place before the walls were built?

Many years ago Ferranti embodied his belief in the economy of large electric generators and long distributing lines in the Deptford 10,000-volt transmission scheme to feed the Metropolitan area. London would have none of it, and was divided up into many sections. Sixty-two rival small stations "grew in beauty side by side," as the poet hath it, and Ferranti's schemes were stunted. After many days big generators and wide areas are coming into vogue. American and Continental manufacturers, having in the meantime found scope in the development of their power supply systems, have captured the new market in England; while home manufacturers are just yawning themselves awake. Witness the pæan recently emitted by a contemporary on one of the first non-microscopic three-phasers built in England: "For a long time past, when anything out of the ordinary run of electrical machinery has been required, we have been accustomed to see buyers placing their orders either in America or on the Continent, and the London County Council are to be congratulated on allowing a purely British firm to show how unnecessary, so far as large dynamos are concerned, it has been for public corporations and others to send their orders to foreign markets. The plant in question is amongst the largest, if not the largest, that has yet been called for." What a big cackle! What a belated egg!

In 1903 Professor Finzi, of Milan, brought out an alternate-current single-phase series motor which had a perceptible starting-torque and efficiency. Have you ever heard, O Reader, of the alternate-current series motor? Take courage—you are but English! It will come to your ears in time; we have already had a paper or two on it at the Institution. But in America and Germany. so soon as Finzi had kicked off, the ball was in the hands of rival forwards, and to-day in America the two great companies—Westinghouse and the General Electric—each have motors which operate satisfactorily on both direct and alternate current circuits. Each has laid down experimental lines on which to run them, and each has equipped and got into commercial working order fairly long lengths of tramway track traversed by cars run by the alternate-current series motor. Germany is no whit behindhand. Its type may differ slightly, but the progress is just as complete. If the equipment of the London-Brighton mono-rail were to be ordered to-morrow, cut price tenders could be obtained from either country with full efficiency guarantees and working drawings embodying the results of commercial tests.

And in the meantime, what have British firms been doing? They have pursued the policy of masterly inactivity. They have been lying low—out-rabbiting Brer Rabbit! If any first-rank British maker has tackled the subject, he has been at particular pains not to let any customer know anything about it. We are a cautious race!

And this is why I would suggest that in place of such a blatant national emblem as a lion in a tantrum, we should substitute a meek, mild, blind, semi-idiotic guinea-pig. It would suit our character better.

Having flagellated the British manufacturer till I am somewhat out of breath, I venture to tell a story of no importance which was related to me some time ago—of no importance, because it only speaks of the crippling of a man's energies during the best part of his life. Yet, if it is typical—what then?

A certain firm engaged a man, who had, among other accomplishments, graduated well on the engineering side of one of our Universities, at the appalling figure of £150 per annum to design dynamos. And in due time, being a man of parts, he was recognised as one of the best designers in the office, and received a certain increase of salary. And it was found that, in addition to grasping the working requirements of the shops, he had constructive scientific ability. He effected minor alterations in design; he attempted to carry through larger reforms, but the inertia of surrounding matter was too much for him. Did the firm, recognising that they had an engineer of genius in their ranks, set him apart for original research? On the contrary, they kept him writing out workshop instructions for repetition orders on their stock lines till he grew tired and found another berth. His next place was a Professorship at about £500. The firm went on manufacturing its old types.

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Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

The Destruction of Insects by the Aid of Electricity.

By EMILE GUARINI.



IF criminals, and other undesirables, are killed by the aid of electricity, it should also be possible to mete out a like fate to all those insects which, to the annoyance and loss of the farmer, take up their abode in the upper strata of the subsoil. Though perhaps no one will deny the theoretical possibility of electrocuting a beetle or grasshopper, still perhaps he will wonder why electricians have not already joined hands with the farmer for putting this valuable ally in his possession. As a matter of fact, inquiring minds have not been lacking, at least of late years, but there has rather been a want of systematic experiments conducted with sufficiently effective means. I personally collaborated at the end of the year 1901, with Mr. Palumbo in carrying out some experiments of this kind in the district of Bari. The means at my disposal were, at that time, somewhat limited, and I certainly should never have succeeded in absolutely solving the problem had I not had occasion to make evident a fact which will not fail to acquire great importance in connection with the practical application of other similar methods now proposed. The more damp the earth the less effective is the electric current in its effects upon the insects dwelling therein. We see at once that this is in perfect accordance with theory, as it is nothing more than a special case which obeys the laws of derived currents, in accordance with which the electric current (following the route which offers least resistance) passes through the bodies of the insects to a greater or lesser extent and according as to whether it meets with greater or lesser resistance in ratio to the amount of moisture the earth contains. The bodies of insects, and especially of crustaceans, present a relatively speaking high electrical resistance, and wet earth is a good conductor of electricity. It is thus obvious that a current of electricity, directed into damp soil, will do but little harm to insects dwelling therein. In the course of my experiments mentioned above, I was able to note that precisely the action of the electric discharge from an induction coil I had with me, had a varying influence upon the insects infesting the trunk and roots of a tree, according to the degree of moisture of the bark or of the soil at the roots of the tree.

Furthermore, in order to bear out this fact I may mention an experiment which, for the first time, was shown by me at a conference held at Gembloux by the Belgian Agricultural Society. This conference dealt with the various applications of electricity for agricultural purposes. Two vessels, one filled with distilled and the other with salt water (bad and good conductors of electricity respectively)

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are placed in series in an electric circuit. Upon placing a fish in each of them, the unfortunate member of the finny tribe immersed in the distilled water was struck dead, whilst the other swimming about in the brine scarcely noticed the passage of the current provided it did not exceed a certain strength. A similar phenomenon could not fail to take place in the case of an electric current passing through more or less damp earth which, consequently, would be a more or less good conductor of electricity.

At Bari, although I endeavoured to awaken the interest of the local agricultural committee by showing them where to obtain the means for continuing the experiments thus commenced, I soon found that although the field was a good one the minds of the interested parties were not fruitful soil. In the course of subsequent years, however, I had much pleasure in following with great interest the considerable amount of work in this direction, which was being carried on in countries outside Italy. Our readers will doubtless not fail to be interested if I deal with—although briefly—two of the methods proposed for the electrocution of insects which, having been practically experimented with, allow us to hope that the essential parts of the problem have already been satisfactorily solved.

Mr. Helberger, engineer of Monaco, on working in an open field with electrical machinery found, on sinking into the ground metal rods connected to a 110-volt dynamo, that all the insects came out into the open air almost directly the current had been passed through the earth. In view of this curious fact the Bavarian engineer in question suggested a method which could be practically used on a large scale for the destruction of insects by the aid of electricity. The system consisted in sinking into the ground, so as to penetrate the upper strata, metal rods connected to some suitable source of electrical energy. The current passing through the earth could not fail to have an effect upon all life present in the soil, and thus to kill all such life directly provided that its intensity reached certain determined limits. This, however, is a point which can only be decided by experience. Probably for each kind of insect —making an allowance for the nature of the soil—a certain current strength will be required, below which it will not be possible to definitely determine their destruction. Crickets and the like, having crustaceous or armoured bodies, will be the hardest to kill, whilst all others unprovided with such protective covering will be sufficiently sensitive for the purposes of the electric current. The ideal method would be to profit by this circumstance, and then make a selection of the useful and noxious insects that infest the soil. The actions of each one should then be studied when subjected to current, and the soil should be treated so as to electrocute only those which are harmful whilst leaving useful insects unharmed.

The *Electrotechnische Zeitschrift*, in a number which appeared in the spring of last year, contained an article dealing with a series of experiments made in Russia, near Odessa, with an electric apparatus invented by Lokuzejewski, with a view to experimenting as to the electrocution of a member of the coleoptera family, which in the year in question, had been playing havoc with the tender shoots of the growing crops. We know of no better term for describing this apparatus than that of an "Electric Fulminator for Insects." An ordinary dynamo is mounted on a stout truck and is driven by gearing from the wheels of the vehicle itself, so that it does not generate electricity unless the vehicle is in motion. The current generated is conducted to earth by the metal wheels, on the one side, and on the other to a series of copper tipped brushes mounted on the rear portion of the cart, and so disposed as to keep their tips a few inches from the surface of the soil without coming into contact with it. Between the electrified earth and the brushes a continuous shower of sparks took place, which caused all the unfortunate inhabitants of the upper strata of the earth to meet with an instantaneous a death as if they had been struck by lightning. It will be obvious that, if the treatment be sufficiently intense, the insects must be utterly destroyed, but we fear that the amount of current necessary to effect the operation would be so high with this system as to render it hardly economical.

Finally, Dr. Rapace has suggested an electrical method for the destruction of the

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fly infesting the olive-tree; in its essentials this differs but little from the method just described. The electricity is conveyed to the plant by means of a pole and, by the aid of another pole, to a kind of metal panel which the doctor himself invented. By means of this there are produced between the leaves of the olive and the metal panel a quantity of sparks which—the inventor asserts—should suffice to kill all the flies infesting the foliage of the tree. We are of opinion that Dr. Rapace will, with his method, gain a signal triumph over one of the most grievous plagues known to agriculture in southern Europe.

The Chaux-de-Fonds—Locle Power Plant.

THIS plant is one of the few on the Continent which use the high-tension continuous current system with dynamos and motors in series. This feature is sufficient indication that the plant was installed by the Compagnie de l'Industrie Electrique et Mécanique, Geneva. The hydraulic power is supplied by the Areuse, which empties into the Neuchatel Lake, making a total fall of 1,100 ft. on a distance of twenty-nine miles. The present hydraulic plant utilises the third fall of 300 ft.; 70 per cent. of the total output of the river blongs to the communes of Chaux-de-Fonds and Locle, and 30 per cent. to the city of Neuchatel. The water which is utilised by the former localities is brought from the flume down to the turbines in the station, which is located on the Areuse at Combe-Garot, by two penstocks of sheet steel 650 ft. long. From this station the current is distributed at Chaux-de-Fonds and Locle where the energy is transformed and distributed to the secondary mains. The engine-room of the Combe-Garot station at present contains six generating sets connected in series according to the system adopted by M. Thury, and designed to produce at full load 150 amperes at 14,400 volts. In order to keep the current at a constant value, the regulation is carried out by varying the speed of the turbines, and an automatic regulation is produced within certain limits, seeing that the fields of the machines are but slightly saturated. It is found in practice that when the current in the circuit increases, owing to a diminution in voltage which may occur, the resistance couple of the generators increases with the square of the current, and the turbines are thus made to slow up automatically, owing to the increased resistance, and furnish less work in this case. The regulation of the turbines can also be carried out very easily by hand and is effected by opening or closing the turbine gates. In addition to this a type of automatic regulator is used in connection with the machines with a view to obtaining a still better regulation than the above. This system of regulation consists of a series wound motor whose armature oscillates to and from, and is balanced against a spring.



POWER TRANSMISSION LINES IN MAIN STREET, CHAUX-DE-FONDS.

The position of the armature varies with the value of the current. It is connected to a long shaft which passes over all the turbines of the series. This shaft acts by means of a suitable lever mechanism upon the regulating hydraulic motors which operate the inlet vanes of the turbines.

The station is supplied with lightning arresters of the Thury pattern which break the arc by an automatic mechanical device.

The line which connects the main station with the two sub-stations where the power

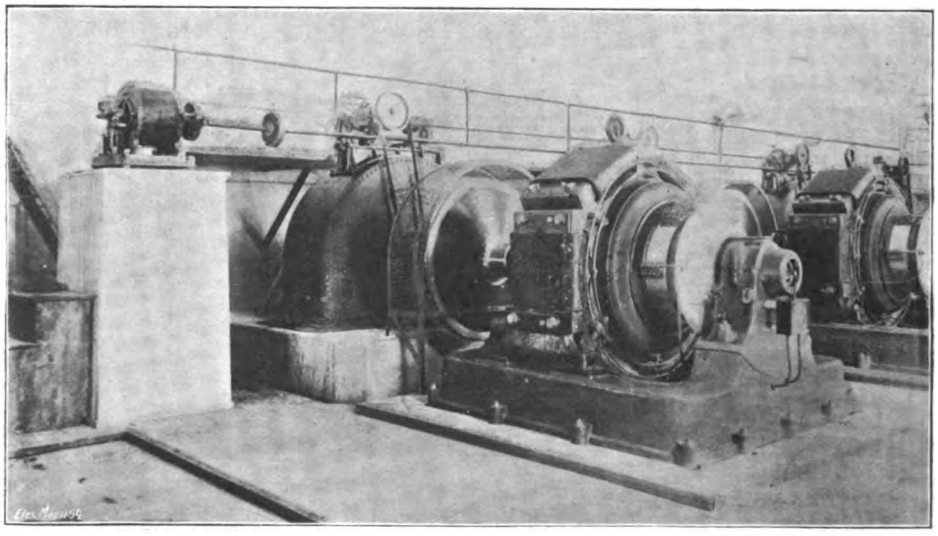
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is received, is a simple series line of two wires. It runs overhead throughout its whole extent. At an altitude of 4,200 ft. it clears the chain of the Jura which separates the Areuse from the Chaux-de-Fonds plant.

The sub-station at Locle is smaller than the sub-station at Chaux-de-Fonds. At first it consisted of but one group of 179 kw., made up of a series which had two generators mounted on the shaft. The pressure of the current delivered was 169 volts. The final disposition of the plant included a reserve station operated by steam, together with a pumping plant for supplying water for the locality. When entirely completed the Locle plant will be made up as follows: first, three sets which will form a reserve during periods of low water; each of these dynamos will deliver 150 amperes at 1,190 volts or 540 amperes at 329 volts; secondly, two rotaries of 200 kw. each, the generator being designed for 329 volts and 600 amperes; thirdly, three rotaries of 179 kw. consisting of a 200-kw. motor direct coupled to two generators for the secondary circuits. Two groups of this kind have already been installed.

The Chaux-de-Fonds sub-station has been laid out for eight motor-generator sets, each having an automatic regulator mounted on it. The regulator is operated by belt from the shaft, and throws resistance into the field-circuit according to the speed of the machine. The lighting circuit of the locality is laid out on the three-wire system. To carry this out, two groups of 200 kw. each are connected upon the outer wires of the system and work at 300 volts. The line is balanced by using two special groups which act as compensators. These groups are made up of a 120-h.p. motor which has a generator mounted on each side of it, and direct coupled. Each of the generators delivers current at 160 volts which is used for balancing the three-wire circuit. As to the main generators which work at 320 volts, their winding has been designed so that they can be also run at 500 volts. This arrangement has been adopted so as to allow the machines to be utilised as reserve groups for operating the tramway circuits, and also to obtain the needed voltage for charging two storage batteries which are used in parallel with the lighting circuit. The 500-volt distribution is operated by two direct-coupled groups of 200 kw. each, in connection with a storage battery. The voltage of the battery is regulated to the required point by a special booster set.

Owing to the increased demand for



INTERIOR CHAUX-DE-FONDS POWER PLANT. *(The Regulator Motor can be seen on the left.)*

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power, it soon became necessary to increase the capacity of this sub-station. This was carried out a few years ago, when it was decided to add three new batteries. The two batteries which supply the 300-volt circuit are charged by the main dynamos of the station. The battery which works on the 550-volt circuit is charged by a booster set, provided with an automatic regulator, which receives current direct from the main line.

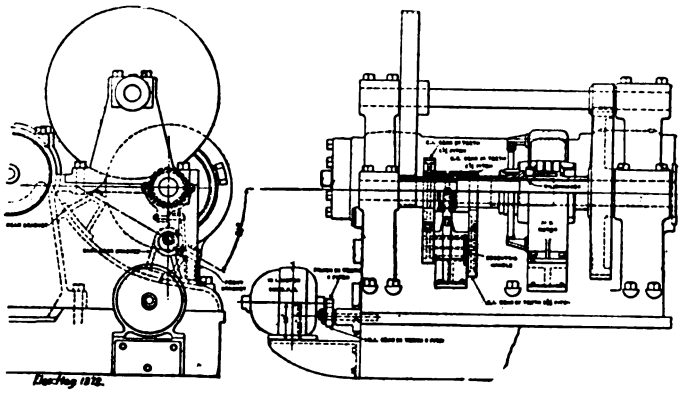


FIG. 1. ELECTRIC MOTOR DRIVE FOR 16-INCH GUN LATHE.

Besides the main plant at Chaux-de-Fonds, it was decided to instal a special reserve station on the premises of the city gas works, as it was easy to obtain a good supply of fuel. Each of the two generator groups used for the reserve is operated by a 250-h.p. gas engine. Any one of the sets can be coupled upon either one of three circuits. First, upon the primary or main line, to which it delivers 1,150 volts and 150 amperes; thirdly, on the lighting circuit giving 320 volts and 540 amperes. The gas-engines are started up by using the generators as motors.

The circuit of the motors is formed of four loops, two of which are at Chaux-de-Fonds, and two at Locle. The main part of the current which is transmitted to the sub-stations is utilised by motors in series which represent a total of 2,000 h.p. These motors operate a corresponding number of direct-coupled generators which furnish the lighting current for the different localities, and also for running small motors. The latter generally operate at two voltages, either 150 or 300 volts.

Motor Drive in a Gun Factory.

THE 14in. and 16in. gun-lathes in the Naval Gun Factory at Washington, D.C., have recently been equipped with Crocker-Wheeler motors, as illustrated in the accompanying cut.

The main driving motor is of a special type built into the headstock, with the armature replacing the old cone pulley. This construction requires an especially large armature bore because of the large diameter of the face-plate pinion shaft that passes through it, and on which it revolves; but it makes possible a very compact arrangement, the motor drive being confined to practically the same limits as required for the discarded cone pulley. Since the speed range required on these lathes is approximately 10 to 1, it was necessary to add a back gear run having a ratio with the direct run of 2.8 to 1. The change from one run to the other is made by means of a double jaw-clutch, operated by a vertical lever, shown at the left of the motor, and directly beneath the clutch collar (Fig. 1). When using the fastest or direct run, the back gears shown below the face-plate pinion shaft are thrown out of mesh by means of an eccentric lever in the manner common to ordinary engine lathes. Driving direct, the motor's working speed range is from 444 to 183 revolutions per minute, giving an extreme ratio of 2.4 to 1 in twelve steps. Throughout this range the motor will develop 30 horse-power. Although lower face-plate speeds can be obtained by running the motor slower, the power capacity of the motor would be reduced nearly in proportion to the reduction in speed. By throwing in the 2.8 to 1 back gear, the lower face-plate speeds can be obtained with ample driving power, since on the back gear run the power demand diminishes in proportion with the speed; the motor, then, of course, has ample power, and may run at any speed and yet be sufficiently powerful

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for all demands of the work. In other words, the demand for power is less with the slow cuts even though they be heavy, and give the false impression of requiring great power. Therefore, using a motor speed range of 444 to 118 revolutions per minute, or a ratio of 3.75 to 1 on this run, gives a total face-plate working speed range of 10.5 to 1 with a possibility of increasing it to 21 to 1, by using even slower motor speeds, if very slow speeds are desired, as when setting up work, &c.

The speed variation of the motor is obtained by the use of the Crocker-Wheeler standard four-wire multi-voltage system, the maximum voltage between the outside terminals being 220 volts. The controller is placed near the tool carriage, convenient to the hand of the operator. The controller itself, which is of the drum type, makes the proper voltage and field-weakening combination for each desired speed, but the main circuit is always broken outside the controller by two solenoid switches. On passing from one voltage to another, a third solenoid switch is caused to open, thereby throwing resistance called buffer resistance —into the main circuit, which prevents any undue rush of current that might otherwise occur. Having fulfilled its function, this resistance is automatically short-circuited at the end of a second or two. There are also two small solenoid switches so arranged that should any of the line voltages fail, the main switches will open, and they cannot be closed again until the controller drum is placed in the "off" position. Push button switches are located at different points on the lathe for the purpose of making quick stops should such emergency occur.

The small semi-enclosed motor shown at the end of the headstock is a 10 horse-power shunt motor for giving a quick traverse to the tool carriages, and is only used when traversing the carriage at high speed, as is desirable when shifting from one part of the work to another, &c. The feed and screw-cutting motions are, of course, derived directly from the gearing driving the face-plate. The specifications for the 16in. turning and boring lathes, which were built by Wm. Sellers and Co. some years ago, state that the bed is 73ft. 10¾in. long, 9ft. wide, and 2ft. deep, and is made in two sections. The lathe was designed to give a safe cutting pressure of 140,000 pounds on 50in. diameter when running at .4 R. P. M. An interesting feature of this lathe is that the tool carriages, of which there are two, are fed along the bed by a long nut revolving on a 6in. steel screw fixed in the headstock, and at the far end in the tailstock end of the bed. The carriage nut receives its feed motion from a square feed shaft driven from constant gears on the headstock, and its quick traverse from the small motor already described.—*Machinery, N.Y.*

MOTOR DRIVE FOR MACHINE TOOLS.

THE convention of the National Machine Tool Builders' Association in Washington, April 11-12, elicited a discussion of the application of individual variable-speed motors for the driving of machine tools under the following heads:—1. Advantages of the motor drive and the greater power necessary in the belt drive for machine tools; 2. Relative cost of power for belt-driven and motor-driven machine shops; 3. Standardization of motor drives.

It was pointed out that, in equipping a new shop with the motor-driven tool over the belt drive, a saving could be made in the initial cost of the power plant. It has been demonstrated that the average loss in the shafting and belting amounts to at least fifty per cent. of the total power of the engine.

With electrical transmission, assuming that the shop is to be driven at seventy-five per cent. of the generator output to give good efficiency from the generator itself, the loss between the engine shaft and the line will be about six per cent.; the line loss, two per cent., and the average loss in the motor itself, seventeen per cent.

Attention was called to the fact that the loss in the shafting and belting is practically a constant loss, whether the shop is operated at its full capacity or not. The loss in the case of the electrical transmission varies practically with the power used. A case was given in which it was desired to operate only a few tools in the shop, for which about twenty-five horse-power would be required; and a spare engine of about thirty-five horse-power capacity was started up to do the work. It was found that this engine would not turn over the shafting, and upon careful investigation of the entire power plant it was discovered that over fifty per cent. of the power was consumed in the shafting alone.

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A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

*Line Construction for High-Pressure Electric Railroads.**

By G. A. DAMON and T. VARNEY.



THE single-phase high-pressure trolley has arrived and evidently has come to stay. The advantages gained by delivering energy directly to a car without the necessity of an investment in synchronous converters and heavy feeders has long been recognised. That it is entirely practicable to take current from a high-pressure conductor by means of a moving contact has been fully demonstrated. It has required some time to show that there is a field for a single-phase traction motor sufficiently promising to justify its commercial development, but a number of motors of this type are now upon the market and within the last few weeks have been put in actual every-day operation.

Three Classes of Construction.

The successful use of a single high-pressure trolley wire will have a marked stimulus upon three distinct branches of the electric railroad art:

1. Moderate speed and inexpensively equipped electric lines for country districts.
2. High-speed interurban roads for service between large centres of population.
3. Electrification of steam railroads.

This will leave the city systems with their suburban extensions to be served, for the present at least, by the direct-current motor. In studying the methods of line construction it will be desirable, therefore, to keep in mind that each of the three classes of roads indicated will have its own individual problems and requirements.

Lines Already Built.

It will be instructive to examine the details of construction of several high-pressure trolley lines already in operation. There are details available of three installations in Europe—Valtellina, Spindersfeld, and the Huber system. There are several other lines building in Europe, but either the details of the line work have not been disclosed or the systems adopted are similar to the ones described. The Valtellina line is really a

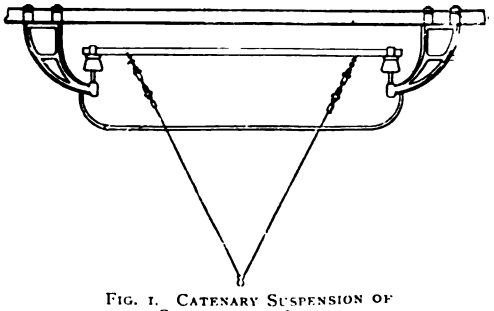


FIG. 1. CATENARY SUSPENSION OF SPINDERSFELD LINE.

* *Abstract of a paper presented before the A.I.E.E., March 21, 1905.*

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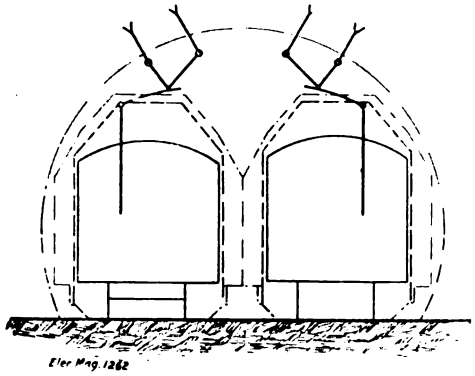


FIG. 2. HUBER COLLECTOR IN TUNNEL.

three-phase road having two trolleys, but the line construction could easily be adapted for a single trolley. The line is 66 miles long, with three branches; is located near Milan, Italy, and has been in operation since September, 1902. The trolley pressure is 3000 volts at 15 cycles. The transmission line, at 20,000 volts, is carried on the trolley poles. The contact wires are fixed at a height of 20 feet in open stretches and at 16 feet in tunnels. The trolley wires are hard-drawn copper wires of 8-mm. diameter, and the span wires consist of galvanized steel wires of 5-mm. diameter. The span wires which hold the trolley wires, after the usual suspension method, are attached to the poles by porcelain insulators of a special type. The contact wire is suspended by ambroin insulators consisting of a cast-iron bell holding a steel bolt imbedded in ambroin and having a mechanical clip at its lower end. The insulators are tested to 10,000 volts.

The Spindersfeld line is a single-phase experimental electric line installed on the State Railroad near Berlin. The line is three miles long; it was put in operation in June, 1903. The trolley pressure is 6,000 volts at 25 cycles, single-phase system. The trolley wire is hung from two steel catenary wires with suspensions every 10 feet. (Fig. 1.) The steel wires also act as current conductors. The copper wire is of 8-mm. diameter; this seems to be the standard size on foreign roads. This wire is slightly smaller than No. 0 B. & S. gauge. The contact device is a sliding bow. On parts of the line a single catenary suspension is used, the double catenary being a later development, having been adopted to insure greater safety and to increase the lateral rigidity of the conductor.

Underneath the bridle wire there is an earthed bar, so arranged that a break in the line or in the catenaries will cause a contact to be made with the live conductor, grounding the system and throwing a circuit-breaker, and thus protecting the line.

An experimental line has been built by the Oerlikon Machine Works after the plans of E. Huber, technical director of the Company. The line uses a single-phase current at 14,000 volts directly on the conductor wire. The current-collecting device is of

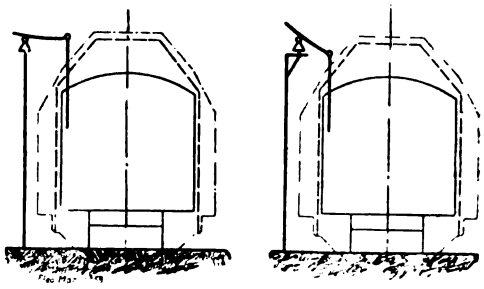


FIG. 4. HUBER COLLECTOR AT TOP AND SIDE OF WIRE.

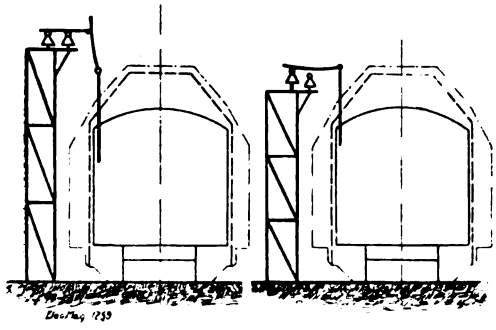


FIG 3 HUBER COLLECTOR AT SIDE AND TOP OF WIRE.

novel design; it consists of a curved metallic stem with its convex surface bearing lightly on the top of the current-carrying conductor. Normally the wire is located at the side of the car, but in passing through a tunnel or under an over-head crossing, the wire can be brought over the centre of the track. The collecting stem has a rotary motion in a plane perpendicular to the track; the position of the stem at any time is regulated automatically by the location of the overhead conductor wire. Figs. 2 to 7 indicate diagrammatically the various relative positions of the collecting device and the wire.

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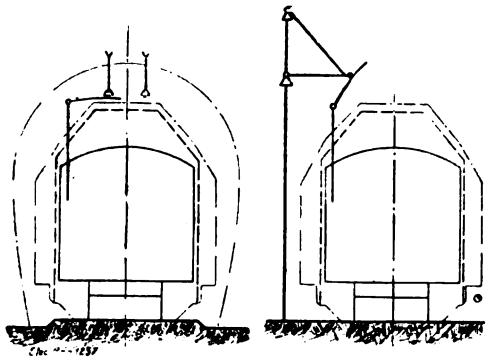


FIG. 5. HUBER COLLECTOR BELOW WIRE.

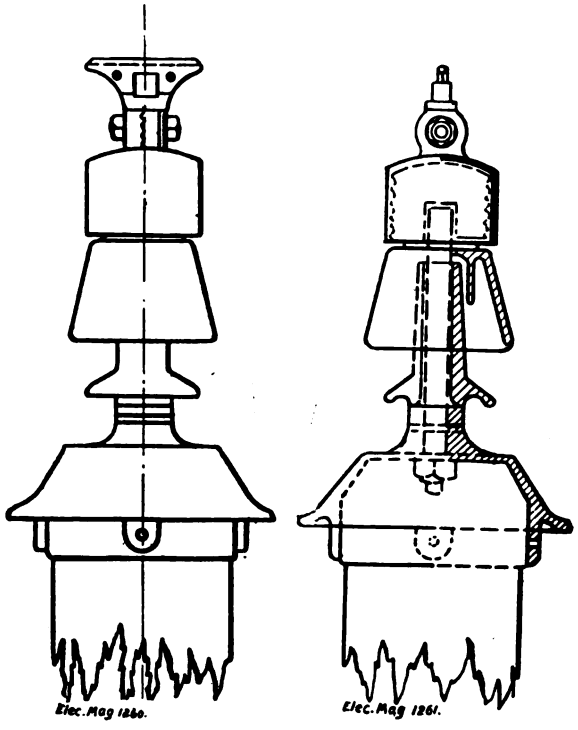
In making contact with the wire when over the car the collector arm rubs beneath the wire, but this is only done in tunnels and in other contracted spaces. The current collector is mounted on porcelain insulators and the light arm is held in place in such a way that it can readily be removed and renewed. The entire device is further mounted on a parallel link motion, which is controlled automatically so as to shift the centre of rotation of the contact stem when required.

The side wire is carried in mechanical clips held in place on the top of the poles by special porcelain insulators made large enough to stand a test of 30,000 volts. The entire line has withstood a test of 16,000 volts. The average height of the contact wire alongside of the track is 15 feet, and inside tunnels 16.5 feet. The distance between supports is about 100 feet.

An American road five miles in length has been in operation for about five months, and upon this road several forms of construction have been installed. One portion has been equipped with 120ft. spans with sags of 24in. in the messenger cable. Another section has spans of about 96ft. and sags of about 4in. In the latter case both messenger and trolley wire are tighter than the former. The effects of temperature upon these two forms of construction are indicated by the following observations during a period of two months:

Date.	Temperature Fahr.	Height of Trolley Wire above Rails.	
		Span No. 1.	Span No. 2.
		120ft.	Span.
12 22-04	33.8°	21ft. 3.4in.	21ft. 5.1in.
12-23-04	52.3°	21ft. 2.0in.	21ft. 3.6in.
1- 4-05	16.0°	21ft. 4.1in.	21ft. 5.5in.
		96ft.	Span.
12-22-04	34.7°	20ft. 7.0in.	20ft. 7.5in.
12-23-04	52.3°	20ft. 6.8in.	20ft. 7.4in.
1- 4-05	14.7°	20ft. 7.4in.	20ft. 7.9in.

The greatest temperature variation noted on the 120ft. spans was 36.3° Fahr., and the corresponding changes in height at the centres of the spans were 2.1in. and 1.9in. respectively. For the 96ft. spans the temperature variation was 37.6° and the corresponding changes in height were 0.6in. and 0.5in. respectively. The combined weight of messenger, 000 trolley wire, and hangers averages 1lb. per foot, which gives a tension in the messenger cable with 120ft. span and 24in. sag of about 900lb. The tension with 96ft. span and 4in. sag is about 3,500lb.



FIGS. 6 AND 7. INSULATOR AND COLLECTING WIRE FOR HUBER SYSTEM.

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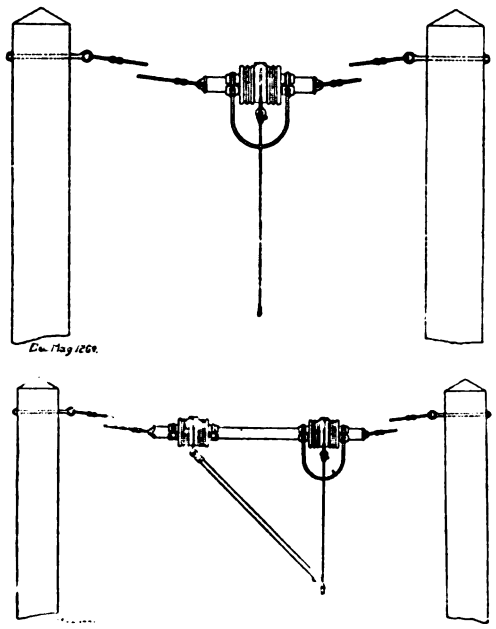


FIG. 8. CROSS-SPAN SUSPENSION, WITH AND WITHOUT STEADY STRAIN.

For best results with this form of construction both as regards cost and operation, the following arrangement is considered satisfactory: the spans should be 120ft. long on straight track, reducing the length as may be necessary on curves. The messenger to consist of a 0.4375in. galvanised Bessemer steel cable composed of seven strands and having an ultimate strength of about 6,000lb. The trolley wire to be 000 grooved section supported in horizontal position by hangers placed 10ft. apart. The messenger cable is to be pulled up to a minimum cold-weather sag of about 11in., corresponding to a tension of about 2,000lb. For conditions where bracket arms cannot be used, cross-span work may sometimes be employed. For this purpose the arrangement indicated in Fig. 8 has been designed. The difference between this arrangement and the bracket-arm construction is the substitution of a 0.4375in. steel span cable for the bracket.

For the heavy service requirements of steam roads having from two to four tracks, the construction described above is not adequate; a more substantial equipment and one which will not encroach upon the present standard clearances is necessary. Obviously, the best form of support to accomplish this result is a bridge long enough to span all tracks with ample clearance on the sides and overhead, and stiff enough to carry all of the overhead conductors without undue vibration. Bridges of this character are at present in use on many roads to support semaphores and other signal apparatus.

Fig. 9 indicates a signal bridge which has been devised for a four-track road carrying, beside the semaphores, the four sets of cables and trolley wires suspended below the truss. This construction is a decided advantage in erecting, as the cable and trolley wire can be run out along the track and lifted into place. Massive porcelain insulators will be used mounted on heavy pipe and fitted with collars having soft lead strips under them. From these the cables will be hung by means of bolted clamps. By anchoring all cables to the bridges after being drawn up to a uniform tension, the effect will be to steady the bridges. For roads having wide rights of way comparatively light bridges steadied with guy cables may be used, but for most cases a substantial structure similar to those now used for signal towers will probably be preferable. It will be noted, however, that owing to the comparatively long intervals between signals only a few of the bridges carry semaphores; the others may be made lighter than the one indicated in Fig. 9.

Spans of 300ft. for straight tracks appear to be satisfactory, not being so long as to permit undue vibration in the cables, and not so short as to require a large number of bridges per mile.

For the messenger cables 0.625in. extra-high strength steel strands are suitable. With a 0000 grooved trolley wire and hangers spaced 10ft., the average load per foot on each cable is 1.43lb., and with a vertical sag of 2.7ft. the tension is 6000lb. In a rough climate, wind and sleet will at times increase this tension; assuming that the tension may be doubled, a factor of safety of about 3.5 will still remain, as the breaking strength of the cable is about 40,000lb. For use in localities where milder weather conditions may be assumed, lower grades of steel may be used having breaking strengths for the same weight per foot of 25,000lb. and 19,000lb. These latter cables are somewhat easier to handle, and would be sufficiently strong for most conditions. The sag given above is taken to be the cold-

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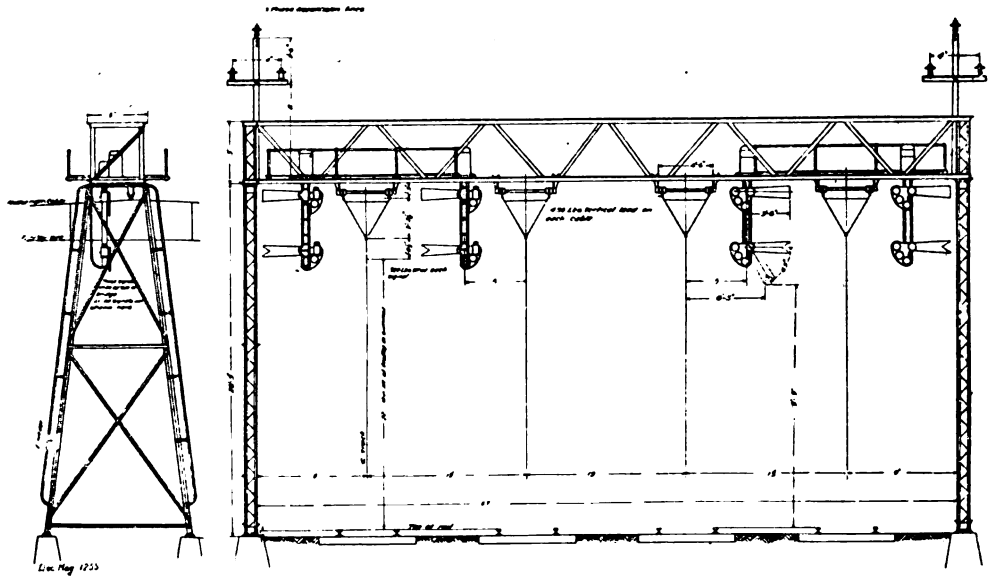


FIG. 9. BRIDGE FOR FOUR TRACKS, CARRYING SUSPENSION WIRES AND SIGNALS.

weather condition, and for 100 deg. Fahr. rise the sag would be about 4.4ft., or a variation of 1.7ft. In Fig. 9 this allowance is made in the height of the bridge, so that the lowest point of the trolley wire will be 22ft. above the track. It is not believed that the variation will be this much on account of the giving of the supports and other causes.

Aside from the work described above, 40 miles of road using the single catenary wood-pole construction have been put in operation in Indiana. This has been in successful running order since the first of this year. The remaining 60 miles of this road will probably be completed in the near future. Fig. 10 is of interest in showing the type of air-operated sliding-bow trolley in use on this road.

Requirements of Installation.

Bearing in mind the distinct requirements of the three classes of roads already referred to, the problem of line construction may be discussed under the following heads:

1. Pressure and Insulation;
2. Location of Conductor;
3. Requirements for Safety and Stability.

As an entire paper might be devoted to any one of these subjects, there is offered an opportunity for considerable discussion.

Pressure and Insulation. — The single-phase lines now in operation in this country have 3300-volt trolleys, and several lines under construction have also decided to use this pressure. Even if a few of the first roads are built with a 3300-volt trolley, there is no reason why, with the catenary suspension, the insulation provided should not be capable of standing a working test of 6000 volts, so that when the time comes to double the pressure the expense of the change will be a minimum. The catenary form of suspension affords so convenient a method of insulation that it should become standard practice for interurban electric lines. When selecting an insulator for this construction, mechanical strength should be the first consideration, and a few cents more spent on the insulator will insure an abundance of insulating qualities.

It has long been admitted that dry wood is one of the best insulators. The convenience with which a wooden rod fitted with suitable terminals can be worked into an overhead construction will commend this form of insulation. Impregnated with an insulating compound, and of sufficient length to withstand high pressure tests, the long wooden insulator is applicable to the insulation of guy wires, anchors, and cross suspension wires. Its use in actual practice will be watched with interest. The use of a wooden bracket to hold the insulator for supporting the catenary will probably appeal to some as a step backward. As far as

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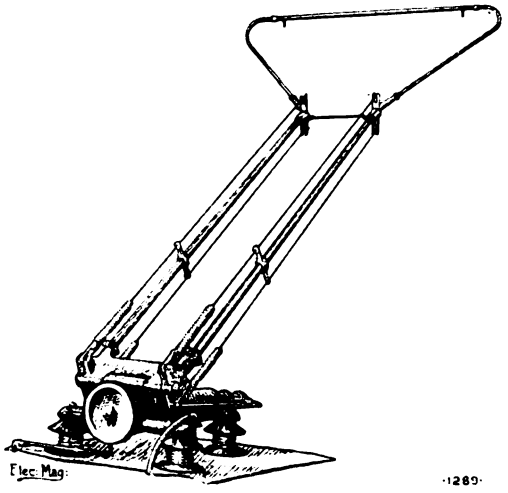


FIG. 10. AIR OPERATED SLIDING BOW COLLECTOR FOR HIGH VOLTAGE WORK

looks are concerned, however, it may be said that a wooden bracket of a section 3.5 by 5 inches presents an appearance fully as attractive as the ordinary cedar pole to which it is attached; and that a double-track road with a line of centre poles equipped with wooden brackets will be much less offensive from an æsthetic point of view than a double row of side suspension poles raked outward in the usual fashion. The wooden bracket has an element of safety not possessed by an iron support, as the insulating properties of the wooden arm would be useful in the case of the failure of an insulator. Unless the wooden bracket were wet it would safely hold up a 6000 volt catenary until the line could be repaired.

Location of Conductor.

For moderate-speed roads the natural tendency will be to have the trolley wire where it has proved to be so thoroughly satisfactory, that is, over the centre of the track, and to continue to use the present trolley-harp and wheel. For speeds not exceeding 40 to 50 miles an hour at trolley pressures up to 3300 volts, this arrangement will work satisfactorily.

For high speed electric lines there will be little objection to the conductor wire remaining over the track, provided it is properly suspended; but the danger of the ordinary trolley wheel jumping off the wire at high speeds will, no doubt, suggest the use of some form of collector other than the wheel. The bow, the roller, and the shoe will each find advocates until more experience has been obtained and the results are reported and discussed.

The Huber system appears to have been carefully worked out and at the present time is the best suggestion for a solution of the line problems in connection with the electrification of steam roads. There is one serious objection to the arrangement, but this can be overcome. The contact wire carried from pole-top to pole-top is liable to break, and some form of support should be devised to prevent the broken ends falling to the ground. A double-catenary suspension system with one wire carried on an insulator at each end of a cross-arm attached to the pole, say a foot from the top, could be provided, and the contact wire could be supported from the apex of triangular supports attached to the two catenary wires. This method would offer advantages over any system of guard-wires or cradles which might be devised to catch the broken wire, as it would require three wires to be broken before any part of the system could fall to the ground.

Safety.

Whatever method of construction is followed, every precaution should be adopted to prevent accidents to the public or employees from the loose end of a broken live wire. Suspensions or supports properly installed every 10ft. to 15ft. will lessen this danger. With bracket constructions having poles about 100ft. apart, there will be no need of a double catenary suspension for the wire which is to be used with an underrunning collector. In such a case, the double suspension would mean twice as many insulators as would be required with the single catenary, thus decreasing the insulation resistance and increasing the chances for trouble. The frequent clips holding the contact wire are not only advantageous from the standpoint of additional safety, but they contribute to the permanency of the construction by keeping the wire almost perfectly horizontal at all temperatures, and thus avoiding the bending of the wire up and down at the support points every time the collector passes. The only disadvantage to clips holding the wire every few feet is the tendency for the trolley wheel to spark at these points. This is not a serious objection if a collector similar to the bow device is

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used, in which case there will be no interference between the collector surface and the mechanical clips.

In a hard sleet-storm every attachment connected to the wire will naturally be the cause of additional trouble. The arcs due to a coating of ice between the wire and the collector will be much more vicious at 6000 to 15,000 volts than at 500 volts, but there is no occasion to become alarmed at the possible danger from this source. In this country one of the high-pressure lines using a trolley wheel on a 3300-volt wire has already passed through a hard siege of sleet; and, though the sparking was spectacular, very little damage was done. The frequent trolley supports, however, added considerably to the sparking.

Greased trolley wires are sometimes used to prevent the trouble caused by sleet. It is well known that the grease finish of an aluminium wire prevents the collection of sleet upon the wire, and it may be possible that a coating of grease on the high-pressure conductor wire would entirely obviate this trouble. It is evident that with a collector taking the current by means of a contact made on the top of the wire, as in the Huber system, the trouble from sleet would be a minimum.

The transmission lines from the power-plant to the sub-stations will be at a higher pressure than the trolley pressure, and will therefore require careful treatment. For a road which is to be built economically, a single set of transmission wires serving all of the static transformer stations in parallel will be sufficient. These transmission wires will ordinarily be carried on the tops of the same poles which support the trolley bracket. The next refinement would be to have a separate set of transmission lines from the power-house to each sub-station, making it possible to put the overload protective devices on the central-station switchboard and thus eliminate the sub-station attendance. With this multiplicity of wires and consequent higher first cost adopted, it is but one step farther to separate entirely the two systems and to install two pole lines on the same right of way; where the electric road is of the high-speed class this should be done. The first investment in the transmission line, the cost of maintenance, and the loss by leakage—all these can be cut in half by thoroughly grounding one side of the single-phase transmission line so as to use the earth as one leg of the circuit. An actual trial of this suggestion to further simplify the distribution system is under contemplation, and no doubt will furnish valuable information as to its effect on telephone and telegraph lines as well as data in connection with the resistance of the earth with alternating currents.

*Car Wheels—A Study of Their Costs.**

By D. F. CARVER.

CAST-IRON car-wheels in hard city service wear away at about 1 lb in weight of wheel per 1000 wheel-miles' run, and although the metal worn away costs only a little more than 1½ cents per pound in the new wheel, the scrap value of the remaining part of the used-up wheel is approximately 65-100 cent per pound. This difference in value between new metal and scrap metal, plus the first cost of that which has been worn away, shows that for all practical purposes to the railway company, the part of the rim which has been destroyed has cost 14.95 cents per pound (including labour at shops and material), or $5.23 per wheel, made up of

Depreciation	$3.74
First cost of that worn away	.54
Labour	.95
Total	$5.23

That is to say, the depreciation in value to the railway company of its unconsumed worn out cast-iron wheel is seven times more than the actual first cost of the part that has been destroyed. In a consideration of wheel costs, some basis of comparison must be used, and for comparison only it has been assumed that the wheels will average (for 33-in. cast-iron, chilled, spoked type) 450 lbs. in weight when new; that the new wheel costs 1.55 cents per pound; that its scrap value, f.o.b. car shops, is 65-100 cent per pound, and that the average life of such a wheel at this cost should be 35,000 miles.

In the diagram, Fig. 1, the axis of x, or abscissas, represents 1000 miles' run per wheel. The y ordinates represent on the left $1 for each horizontal line, and on the right 10 cents for each horizontal line. The line A then shows the value of

* *Street Railway Journal.*

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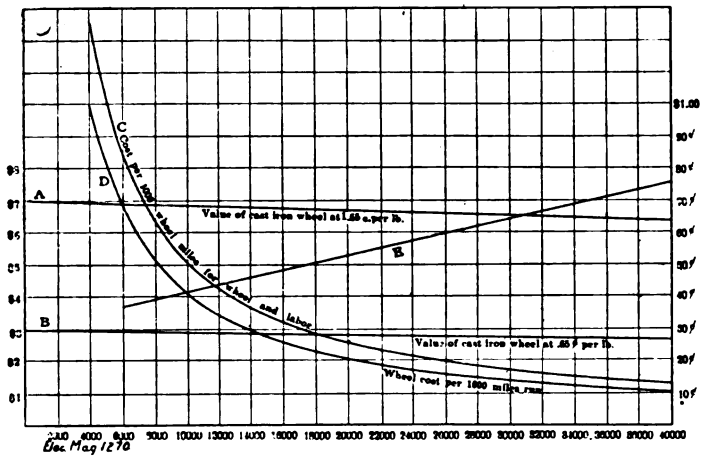


FIG 1.—DIAGRAM FOR DETERMINING SERVICE AND SCRAP VALUE OF NEW AND WORN CAST-IRON WHEELS.

the wheel at the successive mileages of its life, or its weight for the time being, at 1.55 cents per pound. The line B represents the value of the wheel at the successive mileages of its life, or its weight for the time being, at its scrap value of 65-100 cents per pound—both referred to the left-hand ordinates.

The line C represents the cost per 1000 wheel-miles of the wheel, both labour and material, at the successive stages of its wear, and the line D represents the cost per 1000 wheel-miles of the wheel only, f.o.b. company's shop, at the successive stages of its wear. The values of the ordinates of both of these curves are those at the right of the diagram.

Suppose that a wheel breaks after running 20,000 miles and is, of course, practically useless. A reference to line D at the 20,000-mile vertical shows that for the time the wheel in question was in actual service its cost-rate to the company—wheel only—for the time it could be used was 20.8 cents per 1000 wheel-miles, and a reference to line C on the same vertical shows that the total cost of labour and material has been at the rate of 25.6 cents per 1000 wheel-miles. It also appears that for a 35,000 miles' run, which is the assumed life of the average wheel, the rate per 1000 miles for labour and material has been 14.96 cents per 1000 miles, and that the cost per 1000 miles of wheel only has been 12.25 cents.

This line C shows a number of things. It shows that if the track is bad at special work and is breaking flanges, every wheel that is broken at 6000 miles run, for instance, has cost the company 84 cents per 1000 miles. It also shows why it is economy to spend some money to grind up a comparatively new wheel, but rather doubtful economy to spend very much on a wheel that has done 28,000 miles or 30,000 miles.

The line E. Fig. 1, shows the value of a wheel at different mileages run, computed on the assumption that standard wheels at a first cost of $6.98 per wheel (1.55 cents per pound) should run 35,000 miles. If one bought with such a contract, he would want to know how much a wheel that had only run, say, 32,000 miles, was worth to him. To determine this point, follow the 32,000 vertical line to its intersection with line E, and this point, on the left-hand ordinates, will be found to be $6.63. Conversely, if it ran over its guarantee, or, say, 40,000 miles, the intersection of line E with 40,000 will be found at $7.60, the equitable value of the wheel. Of course, line E is straight, and it is interesting to note that its origin at $x = 0$, is at $y = \$2.92$, equal to the scrap value of the wheel, for it is obvious that if the wheel could not be run its value was only scrap.

It will be noted from this line that, in establishing a base rate of price per 1000 miles' run, it is well to establish the standard of price at some point close to the limit of wear of the average wheel, because if taken at 28,000 miles, for instance, the amounts payable for wheels showing long life would be quite considerable. That is to say, the base price for wheels on a mileage basis should be computed at an average, which is as near, as may be judged, to the cost price per wheel per 10000 miles' run, when scrapped.

It will also be noted that in relation to the line E, for any value of x in 1000 miles;

y (in cents per wheel) $= x \times .0116 + 292$

where the mileage cost per wheel is on a 35,000 mile basis. So much for the cast-iron wheel.

(*To be concluded.*)

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Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

*Some Tests of Tantalum Lamps.**

By A. E. KENNELLY and S. E. WHITING.



SINCE tantalum incandescent lamps have so recently been developed commercially, some tests made by the writers upon a few samples of these lamps may be of interest.

A batch of ten tantalum lamps was received through the courtesy of Mr. Edward D. Adams, who obtained them from Messrs. Siemens & Halske, of Berlin. These lamps were all alike. All of them had frosted globes and were marked uniformly 110-25, which was interpreted to mean 110 volts and 25 normal horizontal hefners (22 normal horizontal British candle-power).

Figs. 1 and 2 indicate the behaviour of one of these lamps (No. 2) in respect of resistance, current, power, luminous intensity (horizontal candle - power), luminous efficiency and specific consumption (watts per candle). The corresponding data are indicated also, in dotted lines, for a particular Edison carbon filament lamp nominally of 120 volts, 16 cp, and 3.1 watts per candle, in a frosted globe. This particular lamp was taken at random from a number of similar lamps which had been in service about 50 hours. No attempt is made, therefore, to present an accurate comparison between the tantalum and carbon types of lamps, but only their general relative behaviour. It is possible that, if the carbon filament lamp had been specially selected, its behaviour would have been superior. On the other hand, if the tantalum filament lamp had been specially selected from the batch tested, its behaviour also would have been superior. The results given in the curves are to be interpreted, therefore, as showing the qualitative relative behaviour of the two general types of filament, carbon and tantalum.

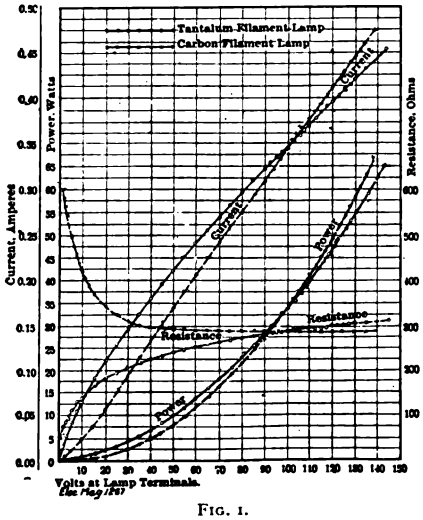


FIG. 1.

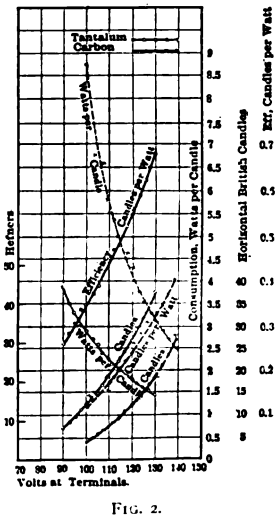


FIG. 2.

* *Electrical World and Engineer.*

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The carbon filament (Fig. 1) had an initial resistance of about 600 ohms at the normal room-temperature and lowest voltage. As the pressure at the terminals was increased, this resistance fell very rapidly to a minimum of 288.2 ohms at 75 volts, this value being practically constant from 70 to 90 volts. The resistance then rose very gradually to 293 ohms at 140 volts, the highest pressure employed in the test. This curve is characteristic of the ordinary carbon-deposited filament. That is, the resistance of a carbon filament usually reaches its minimum at a voltage lower than the working voltage.

The tantalum filament had an initial resistance of about 55 ohms at the normal room temperature and lowest voltage. It rose rapidly at first and afterward more slowly as the terminal voltage increased. The highest resistance observed was 316.8 ohms at 143.3 volts. The resistance was still rising at this point, as shown by the curve. Whereas, therefore, the carbon filament falls under operation to about half its cold resistance, the tantalum filament rises under operation to about five and one-half times its cold resistance. On this account the initial rush of energy into the tantalum filament must be about ten times as great as in the carbon filament. The time allowed for the tantalum filament to reach its working temperature is, by inference, materially less than for the carbon filament. It would be interesting to investigate, from this standpoint, the possible influence of frequent turning on and off upon the lifetime of the tantalum filament.

Under operative conditions the carbon filament has sensibly constant resistance for the working range of voltages. The tantalum filament increases in resistance about one fifth of one per cent. per volt increase of terminal pressure in the neighbourhood of its normal working voltage. On this account, a given percentage increase of voltage on the tantalum lamp will not produce the full corresponding increase in current strength. Thus an increase of terminal voltage of 5 per cent. would increase the current only about $3\frac{3}{4}$ per cent. Such a property is valuable, since it tends to regulate automatically the current strength passing through the lamp under variations of line voltage. The effect in these tantalum filaments is not, however, very marked at their normal working point, and not so great as the curve shows it would

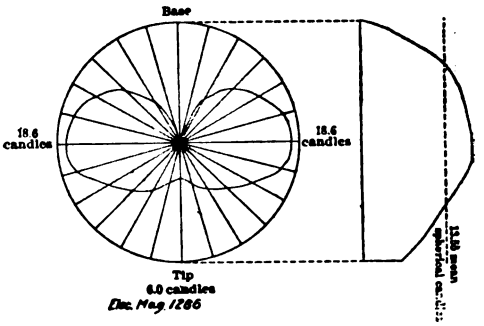


FIG. 3.

be at a much lower pressure, say at 20 volts. Here an increase in voltage of 5 per cent. would cause an increase in current of only $2\frac{3}{4}$ per cent.

The curve of current strength in the carbon fillament is not far from a straight line through the origin. The corresponding curve in the tantalum filament starts rapidly, but drops considerably owing to the increase of resistance. The slope of the current is greater finally in the carbon filament than in the tantalum by about one-third. This is due to the self-regulation referred to under resistance.

The power in the tantalum filament is decidedly greater, relatively, at low voltages and less at high voltages than in the carbon.

The tantalum lamp became appreciably luminous at a terminal e.m.f. of 9.5 volts, or about 9 per cent. of its normal working voltage. The carbon filament became luminous at 24 volts, or about 20 per cent. of its normal voltage. Thus a tantalum filament will begin to glow at a much lower voltage than the corresponding carbon filament. This may prove a useful property in testing and the like.

The curves of Fig 2 show that the horizontal candle-power of the tantalum lamp is markedly greater than that of the carbon lamp. The luminous efficiency, or candles per watt, of the tantalum lamp is also markedly greater than that of the carbon lamp tested. (It may be noted here that the globes of both lamps were frosted.) Thus at 110 volts the tantalum lamp consumed 2.2 watts per candle, while at 120 volts, the normal for the carbon lamp, the latter consumed 4.3 watts per candle. The normal efficiency of the frosted tantalum lamp was, therefore, nearly double that of the frosted carbon lamp. We have no knowledge as to the

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relative duration of life for the two types at these efficiencies.

A small change of voltage produced a somewhat larger change of the candle-power in the tantalum lamp than in the carbon lamp. Thus an increase of 1 per cent. in normal voltage produced 0.7 candle increase with the tantalum lamp, and 0.6 candle increase with the carbon lamp. The lamps were, therefore, nearly alike in the increase of candle-power for a given small increase in voltage, but as will be seen from the curves, the relative behaviour in this respect would change appreciably with a shifting of the chosen working voltages. Consequently not much stress can be laid on this comparison. Since, however, the candle-power of the tantalum lamp was considerably greater than that of the carbon lamp, it is evident that if equal small increase in voltage produces equal increase in candle-power, the percentage of increase will be markedly less in the tantalum lamp.

Distribution of Light. — With frosted globes the change in horizontal candle-power with change of azimuth was negligible in the tantalum lamp. This would be substantially true in an unfrosted lamp, owing to the cylindrical disposition of the filament. In Fig. 3 is given the observed distribution of tantalum lamp No. 2 in a vertical plane. At the tip the candle-power falls to about 6, the horizontal value being 18.6. The mean spherical candle-power was 13.55, which gives a spherical conversion factor of 0.73. The vertical distribution of the tantalum lamp is nearly the same as that of the common type of carbon filament lamp.

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A Field for the Illuminating Engineer.*

By L. B. MARKS.

ALTHOUGH much progress has been made in recent years in the development of various types of electric lamps, the art of electric lighting in so far as this art applies to the proper amount and distribution of light for the illumination of interiors has not kept pace with the development of the lamps themselves.

The electrical engineer may be skilled in designing electric light plants, but when it comes to laying out the detailed lighting scheme of a house, he is apt to fall short for the reason that his training does not, as a rule, qualify him to obtain the best results in this particular field. As a matter of fact it is often the architect, rather than the electrical engineer, who decides the lighting problem and prescribes the location of outlets for lamps. Sometimes the decorator may be called upon to arrange the lighting scheme, and even the fixture manufacturer often has a hand in the matter. Lastly, the owner himself may suggest certain arrangements which though ridiculously extravagant are carried out because no one in particular has direct charge of the whole question of illumination.

This condition of affairs accounts for the glaring defects in lighting which are noticeable in most residences at the present time. In some cases the outlets for the lamps are improperly placed; in others where the outlets are correctly located, the number of lamps on the individual outlets is either too large or too small. In still others, where both of the above conditions are properly complied with, the intrinsic illumination of the lamps themselves may be entirely too great. This last defect is the most common of all. Unshaded or inadequately shaded lamps, hung low in the rooms, are the rule rather than the exception. Lights so hung are exceedingly trying on the eyes and are directly responsible for many a case of nervous headache arising from irritation of the eyes.

On the other hand, one often sees just the other extreme, that is to say lamps so densely shaded that only a very small percentage of the light is useful. Sometimes this shading is done for æsthetic reasons, but in many

* *Electrical Review.—N. Y.*

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cases it is done at the cost of both art and illumination.

The amount and character of the illumination must naturally depend upon the use to which the light is to be put.

In a parlour, for instance, a moderate degree of light, well diffused, is usually the desideratum. In a library a stronger light is needed for reading purposes; a reading lamp with reflector is generally the most economical means of securing this strong light, but other illumination should always be super-imposed in the room in such a case. In a dining-room the illumination of the table is, of course, paramount, but here, as in the last case, the light should not be concentrated on the table to the exclusion of the rest of the room; the whole room should be moderately well lighted. The same general rule holds for the billiard-room also. If the billiard table alone be brilliantly illuminated by localized light, as is often the case, the eye tires much quicker than if there be also a good general illumination throughout the room.

The value of diffused light is frequently overlooked or under-estimated in planning the lighting scheme of a house. Even in cases where economy of lighting is an object, the laws of diffusion and reflection are often entirely ignored, with the result that a great many more lamps than would otherwise be necessary are required in order to produce the needed illumination.

On the other hand, there are many cases in which the number of lamps installed is far greater than is required to give the necessary light. The electrical engineer or the architect, or whoever may be responsible for the lighting arrangements, often provides a large excess of lamps so as to be sure there will be enough. In so doing he takes no cognizance of the fact that when current is supplied by the lighting company, the average charge per lamp for lighting may be smaller or larger depending upon the number of lamps installed. It is not until the bill for current is received that the user realises that his lighting arrangements are extravagant. He then learns that the charge for lighting per kilowatt-hour is based upon the number (or equivalent number) of hours his total lamp equipment is in use, and that the more current he uses within certain limits, the lower will be the charge per kilowatt-hour. As a matter of fact, however, he finds later that he seldom, if ever, gets the benefit of any reduction in charge, for the reason that in normal lamp service he does not use the equivalent of his total lamp equipment for a sufficient number of hours to obtain any reduction. Obviously, had the original lamp equipment been limited to what was necessary for the proper lighting of the establishment, the cost of lighting would be considerably reduced, to say nothing of the saving in the cost of installation.

It is not at all uncommon to find the total lamp equipment in residences to be at least fifty per cent. larger than is actually necessary to give the requisite results so far as satisfactory illumination is concerned. And this statement is true not only of dwellings in which artistic and æsthetic considerations in lighting rather than economy of current are paramount, but also of those in which the decorative feature of the illumination is subordinate and subservient to economy.

In public buildings, art galleries, theatres, churches, and large stores, the importance of careful design in the lighting arrangements is even greater than in the dwelling-house. Although more attention is now being paid than heretofore in these cases, to the details of electric lighting, one still finds at every hand flagrant violations of some of the elementary principles of scientific illumination.

The question of electric illumination has grown too broad to be properly handled by the electrical engineer as such, or by the architect. The problems that present themselves for solution are numerous, and more or less complex and demand the attention of the specialist in illumination — the illuminating engineer, for whom the field is growing year by year.

The scope of the ELECTRICAL MAGAZINE is being constantly extended, and on this account you should not miss a single issue. We have important developments in hand which will increase your interest in this journal.

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For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

Type-Printing Telegraphs.

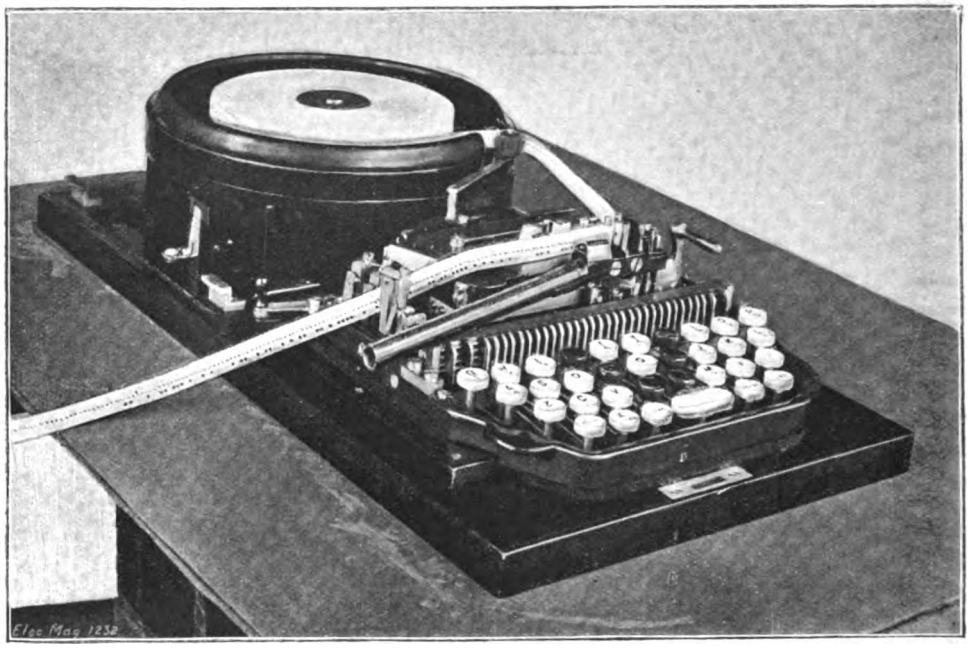
(Special Article.)

By DONALD MURRAY, M.A.



FROM the dawn of electric telegraphy, inventors have been at work filling the patent records with printing telegraph schemes, some brilliant, some stupid, and nearly all useless. Out of several hundreds of printing telegraphs invented prior to the beginning of the 20th century, only the Hughes and the Baudot and the stock-tickers achieved any real success. With the stock-tickers the problem to be solved was comparatively easy. They were only required to work over distances of a few miles. High speed was desirable, but not absolutely necessary. One man, by playing on a keyboard, could transmit messages to a considerable number of subscribers, and there was no necessity to deliver the messages, no need to count the number of words in each message, to sign and time the messages, or to cut up the tape and paste it on telegraph blanks, no need to keep copies of the messages for record, or to put them in envelopes and address the envelopes and send them out by messengers. The conditions were of the simplest character, and the consequence has been that the stock-tickers long ago reached their full development. As for the Hughes, of which about 3,000 are in use on the continent of Europe, it may be best described as a glorified stock-ticker for working over comparatively long distances. It prints on a tape and the speed is limited by the manual dexterity of the operator at the keyboard. The gain compared with the Morse key is small. The Baudot printing telegraph, which is largely used in France, and which connects Paris with nearly all the European capitals, may be described as a multiplied Hughes, as it is equivalent to four and even six Hughes instruments working over a single wire. It is exceedingly ingenious, highly practical, and gives admirable service within its limitations; but it is not a fully-developed printing telegraph system, because it is not provided with a typewriter keyboard for transmitting, and it does not print the messages in page form. It prints on a tape, and it does not save labour to an appreciable extent compared with the Morse key. Its great virtue is that it saves wires. In fact, in France and some neighbouring countries it may be said to have met the want that has been supplied in Anglo-Saxon countries by the Morse quadruplex. The Morse quadruplex and the Baudot might be described as the second stage in the development of the modern telegraph. The third and final stage of completely developed machine telegraphy has only been reached during the past five years. Within this brief period there have arisen the Pollak-Virag, Buckingham, Rowland, Murray, and the Siemens and Halske high-speed telegraph systems. Precisely what impulse has produced them it is difficult to say. Their reception by the Telegraph Administrations has not been enthusiastic. The British Post Office tried and rejected the Buckingham and the Rowland systems, and it took three years to make up its mind to use the Murray system. Other administrations and telegraph companies have

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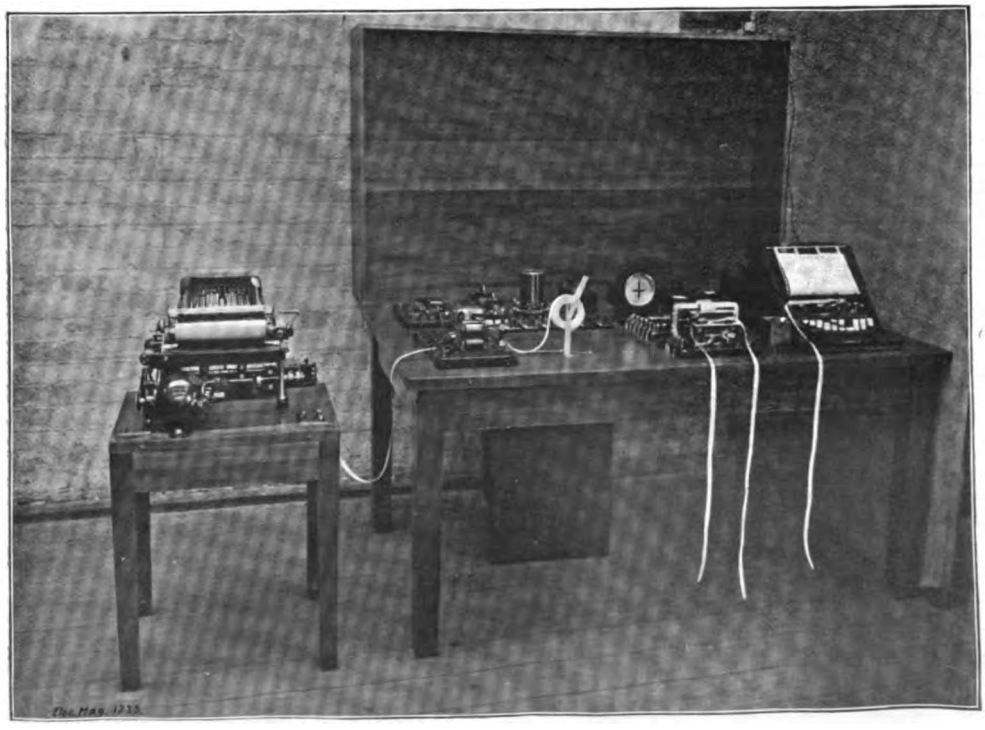
MURRAY KEYBOARD PERFORATOR FOR PREPARING MESSAGES FOR TRANSMISSION IN FORM OF PERFORATED TAPE.

also been moving very cautiously in the matter. The reason lies in the commercial aspect of the question, and as practically nothing is known about this side of the subject outside a small circle of telegraph engineers and Post Office officials, it is proposed to say a few words in this article about the printing telegraph problem from the commercial point of view. There are two money-saving possibilities for a printing telegraph system. It may increase the carrying capacity of the telegraph lines, and it may increase the output of the telegraph operators. That is to say, a printing telegraph may save telegraph wires, and it may save labour. In new countries, and especially big new countries like Russia, America, South Africa, and Australia, the saving of wire is the most important consideration. In fact, a telegraph line 1,000 to 2,000 miles long is so expensive that it pays to waste labour at each end if the the carrying capacity of the line can be increased. It is for this reason that the Wheatstone automatic system, which is very wasteful of labour, is being increasingly employed on very long lines in Russia, South Africa, India, and other countries. Such lines present insuperable difficulties to any ordinary printing telegraph, and the Murray system is the first that has possessed even the potentiality of working over such distances with any degree of satisfaction. These new countries also form a very unfavourable environment for printing telegraphs. Printing telegraphs require a high degree of fine mechanical skill for their construction and maintenance. Skill of that kind does not exist in new countries, and it is only recently that one or two printing telegraphs have reached the stage at which it pays telegraph administrations in these new countries to import and cultivate such skill. These big new countries are essentially rough and ready, and for the rough-and-ready stage of civilization nothing can beat the Morse key and sounder. Even the United States is only now emerging from this rough-and-ready stage of national existence, at any rate so far as telegraphy is concerned, and it is the opinion of those who are in a position to judge, that there will be a great development of printing telegraphy in the United States within the next ten years. The conditions are at last ripe for the change. Saving of wire owing to the great distances in America is important, and saving of labour owing to the high wages is a factor not to be neglected.

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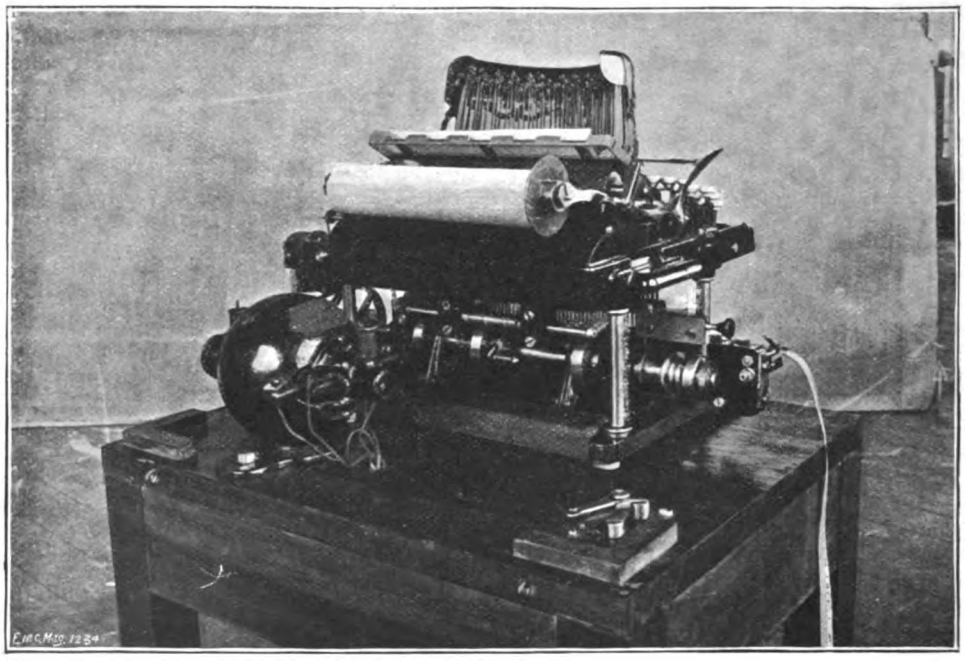
In the old and densely populated European countries, the commercial conditions affecting printing telegraphs are different. In countries like England, France, and Germany, the bulk of the telegraph traffic is confined within each country, the maximum distances instead of 2,000 or 3,000 miles are not more than about 500 miles, and the population instead of being scattered is very dense. These are ideal conditions for the use of the telephone, and the telephone service in Europe has grown immensely during the last few years. The telegraph service has suffered correspondingly. For several years past the number of telegrams transmitted per annum in European countries has been either decreasing or stationary or increasing very slowly. Even in America telephone competition has had a marked effect on telegraph traffic. But in America the great distances and the rapid growth of population still make the increase of the carrying capacity of the wire, that is to say the saving of telegraph wires, an important commercial factor. In Europe, on the other hand, the printing telegraph inventor soon finds that the telegraph adminstrations are indifferent about line saving. They have as many, in fact, in some cases, more, wires than they require at present, and their one insistent demand is for a printing telegraph system that will save labour. This is particularly the case in England, where considerations of public policy have compelled the laying of underground cables, thereby increasing the superfluity of telegraph wires. The French Post Office more than twenty-five years ago took up the Baudot system and developed it until it was capable of transmitting six messages simultaneously over one wire 550 miles long from Paris to Marseilles. The result has been a saving of expenditure on telegraph wires many times out-weighing the expenditure on the Baudot system. It is true that in English-speaking countries the Morse quadruplex has effected a similar saving, but not to anything like the same extent. The Baudot system, however, does not save labour to any noticeable amount, and some very interesting attempts have been made recently to convert it into a labour saving as well as a line saving system.

Summing up the subject in a general way,



GENERAL VIEW OF MURRAY APPARATUS.

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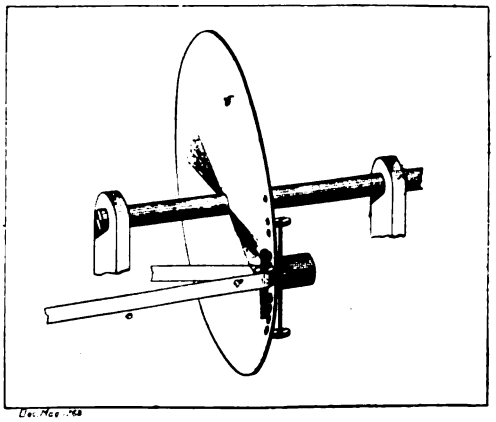
VIEW OF MURRAY PRINTER. IT OPERATES LIKE A MECHANICAL PIANO, UNDER THE CONTROL OF THE PERFORATED TAPE.

we may say that in the big new countries, the commercial conditions are rather inclement from a printing telegraph point of view, and that in the old European countries the growth of the telephone has reduced printing telegraphy to a question of saving labour. This question of saving labour by means of printing telegraphy is a very curious problem and far more intricate than is generally realised even by telegraph men. A few of the difficulties may be briefly explained, and for this purpose we must first distinguish between press and commercial messages. Press messages are long, and generally go to a number of centres. They can be handled in bulk under conditions specially favourable for saving labour by machine telegraphy. In fact, it is certain that within a few years press messages will be handled almost entirely by automatic machinery. With commercial messages, on the other hand, it is a physical impossibility to effect any great saving of labour by machine telegraphy compared with the simple Morse key and sounder. The messages are short, only about twenty words each, and there is no long straight-ahead run of work. It is like a train stopping at every little wayside station. At every twenty words the operator has to stop to sign and time the message, lay it aside, and start on another. At the receiving station, if it is a tape printing telegraph, the attendant has to cut up the printed tape and paste it on telegraph forms, and he must sign and time the messages and check the number of words. If it is a page-printing telegraph, then at the end of every twenty words a fresh telegraph form has to be fed in from a roll, and time must be allowed for the typewriter carriage (or its equivalent) to return to the beginning of each new line. These operations only occupy one or two seconds each, but when they have to be repeated every twenty words the aggregate loss of time is astonishing. If to these small delays we add the losses of time caused by mistakes, corrections, repetitions, and line disturbances, to say nothing of occasional break-downs of the printing machinery and stoppages for adjustment of telegraph instruments, and last, but not least, the fact that the dear public does not send its telegrams in a nice continuous stream, but in gushes, and in a great rush during the three or four hours round about midday, it will be realised that

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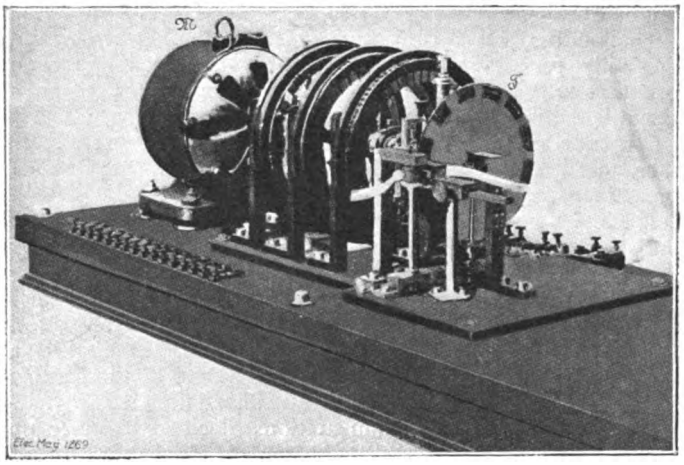
the path of the printing telegraph inventor who aspires to save labour on the handling of commercial telegrams is distinctly precipitous. The amount of work that must always be performed by the human being in connection with commercial telegrams is large in proportion to the amount of work that can be performed by a machine. So far the Murray automatic system has given the best results both from a labour saving and from a wire saving point of view, and in its improved form it is estimated that it saves about 25 per cent. in labour compared with the Morse key, and that it can do as much work on one duplex wire as the Morse key and sounder on two quadruplex wires. Obviously this labour saving is very small compared with labour saving machines in other lines of human endeavour, which in some cases enable one man to do the work of 30 or even more.

Under these circumstances it is not surprising that telegraph administrations have been moving in a rather leisurely way so far as printing telegraphy is concerned. Nor are these the only difficulties the printing telegraph inventor has to face. Assuming that his printing telegraph system works well and gives satisfaction from a mechanical point of view (a very big assumption) and shows some saving of labour, even under the foregoing conditions, he has still to fit his unfortunate system, not merely into one bed of Procrustes, but into half a dozen of them, every one differing in length. A few words about the writer's own experience in this respect will make the matter clear. There are two classes of commercial telegrams, known in England as S and X messages. The former go direct from one town to another, say from Liverpool to London, and are delivered there. The other class of messages go, let us say, from Liverpool through London to Paris. In London these X messages have to be written out as they are received from Liverpool, and then sent on to another circuit for transmission to Paris. These two classes of messages exist in all countries, and most telegraph administrations have two different telegraph forms to distinguish them. Also it is necessary for a telegraph administration to keep a copy of all messages delivered, that is to say all S messages. But the X messages for further transmission, do not require to be copied. In England, carbon copies are made of S messages. On the Continent a note is made of the preambles and the address. A printing telegraph cannot distinguish between S and X messages, and in any case making carbon copies of short twenty-word messages on a typewriter wastes so much time that it is out of the question. Also it is not possible to have two different telegraph forms, one for X and the other for S messages. That means that a special telegraph form has to be prepared for the page printing telegraph, and great telegraph administrations are very reluctant to change their telegraph forms for the convenience of a new and untried invention. It marked a distinct stage in the advance of the Murray system when the British and the German telegraph administrations decided to make up special telegraph forms for use with this apparatus. As for preserving copies of S messages, that difficulty was experienced in the United States when typewriters were first introduced into the telegraph service, and it was found that the only practical solution was to take wet press copies, the telegrams and the damp copying paper being passed through between a pair of power-driven rollers. The use of typewriters in telegraph offices is now practically universal in the United States, and the press copying of telegrams meets all requirements. For some reason that is not quite clear, European telegraph administrations seem reluctant to adopt this plan, and up to the present the preambles and the address of S messages have been noted by hand at the rate of about 15 words a minute, an anti-climax when it is remembered that the



PRINTING MECHANISM OF SIEMENS AND HALSKE SYSTEM, SHEWING ELECTRIC SPARK AND PHOTOGRAPHIC RECEIVING TAPE.

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SIEMENS & HALSKE PHOTO PRINTING TELEGRAPH.

messages are typewritten by the Murray printer at the rate of 120 words a minute. Press copying, however, will no doubt be adopted as soon as page-printing telegraphs come into more general use in Europe. Another trouble is that for the sake of security figures have to be repeated. This is not always done with the Hughes, but with new telegraph systems until they have been proved to be reliable it is a necessity, and the repetition of figures in short 20-word messages obviously reduces the speed and the possible labour saving. A small but unexpected difficulty was encountered in England owing to the shilling stroke and fraction bar in a typewriter being identical. For instance 7/8 may be read seven-eighths or seven shillings and eightpence. In one or two instances merchants have suffered loss through this ambiguity. It is not difficult to provide a printing telegraph with the fractions up to and including 8ths thus $\frac{7}{8}$, but the ambiguity is confined to England, and for International traffic the International Telegraph Convention has specified a list of characters which do not include these fractions.

Space will not permit of reference to difficulties connected with the actual handling of telegraph traffic when printing telegraphs are used. These are not formidable, but they involve a certain amount of change of routine, and routine is a hard thing to change when it is established on a large scale. In England no attempt is made to preserve any record of the messages as transmitted. In Germany, on the other hand, what is known as a "home record" is insisted upon. In the Murray system the perforated transmitting tape is utilised as the "home record," and this tape, in Germany, is carefully wound up into rolls after use for future reference in case of mistake. The received perforated tape is also wound up and preserved in the same way. This is necessary, because the German law makes the individual telegraph operator—and not the Government—directly responsible to the outside public for loss caused by mistakes. The unfortunate operators can be sued for damages for mistakes in telegrams. Naturally, under these circumstances, the German operators go slowly and carefully. In Austria, on the other hand, the operators are paid a percentage on the number of messages they transmit, and they go at a reckless speed. Obviously such conditions are not only diverse, but also adverse from a printing telegraph point of view. Automatitc tape winders are used in America, bu they are hardly suitable for German requirements, and the work is at present done by hand, with a further diminution in the possible labour-saving.

One of the most singular difficulties to be faced by a page-printing telegraph on the continent of Europe is the fact that telegrams are not delivered in envelopes. They are folded up so that the address only is visible on the outside and then sealed with a stamp. For this purpose the address has to be inserted in a special position at the top of the telegraph form. In France it has to go on the back of the telegraph form. With the Hughes and Baudot tape-printing telegraphs this presents no difficulty, as the address can be pasted on anywhere. The saving of labour in a page-printing telegraph compared with a tape-printing telegraph, in which the tape has to be cut up and pasted on telegraph forms, is considerable, but there is also a considerable saving of labour in not using envelopes. There are no envelopes to be addressed and there is no possibility of making a mistake in the address. An ordinary page-printing telegraph cannot automatically start printing a telegraph message and then turn back and

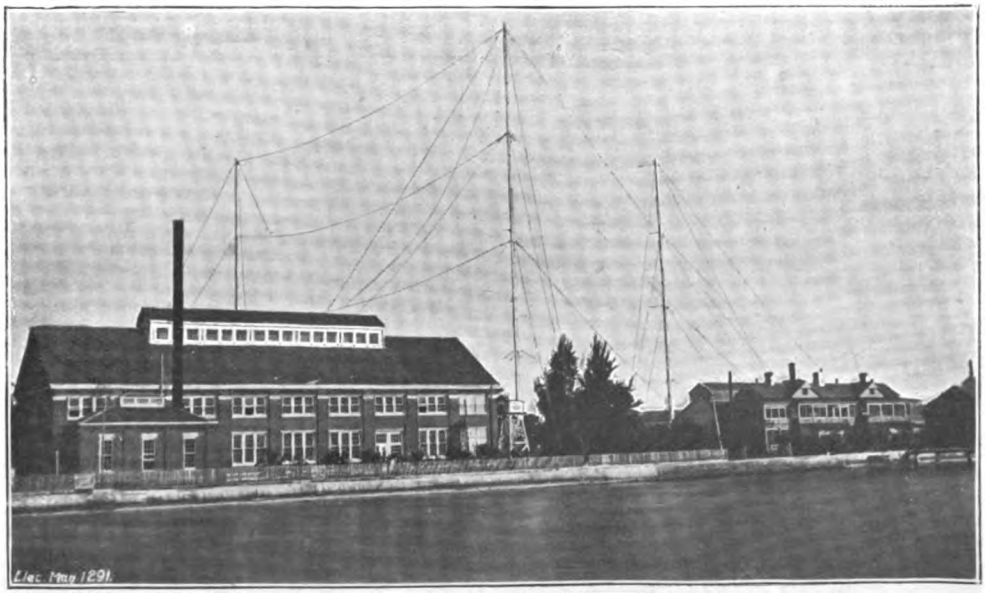
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insert the address at the top of the message, and then turn down and print the text and signature. With a Murray printer, printing from a perforated tape, this is possible if an attendant, who must be present in any case, intervenes to shift the telegraph form in the typewriter carriage at the right moment. An automatic paper-carriage return for turning to new lines was found to be essential in England to save time, much time being lost in running the typewriter carriage back by hand. In Germany, however, this automatic device could not be used owing to the necessity for turning back to insert the address. In France even this cannot be done, as the address goes on the back of the form, and page printing telegraphs cannot be used at all unless the French telegraph administration makes a complete change in its telegraph forms and present arrangements.

In Russia there is a difficulty more formidable than any of these so far mentioned. A printing telegraph for use in Russia must be able to transmit and print Russian or Roman letters at will. Physical limitations render it exceedingly difficult to provide more than fifty or sixty characters in a printing telegraph. The Russian alphabet has thirty-four letters, (omitting two not used), ten numerals have to be provided for, and at least seven or eight other signs, and in addition also twenty-six Roman letters. In the case of four sets of Murray apparatus being made for the Russian Post-office, the difficulty is being got over by having two separate printers at each receiving station, one for Russian characters and the other for Roman characters. An International message in Roman characters will be received as perforated tape with a special signal prefixed. This tape will be run through the Roman type printer. Tape perforated with messages in Russian characters will be run through the Russian type printer.

This is only a very brief outline of some of the main practical difficulties that beset the introduction of a printing telegraph into service into Great Britain, Germany, and Russia. The printing telegraph that will adapt itself to the requirements of all countries will be a miracle indeed, and the opinion of the writer is that printing telegraphy is a good thing to keep out of. No one will ever become a millionaire by inventing a printing telegraph or even half a dozen printing telegraphs. On the contrary, as a means of spending money, it beats horse racing, and it is quite as exciting.

The illustrations have been taken from the *Elektrotechnische Zeitschrift* of 10th March, 1904, and from a paper on "Setting Type by Telegraph," read before the Inst. E.E. in London on the 23rd February, 1905.



DE FOREST WIRELESS TELEGRAPH STATION AT KEY WEST *(see page 446).*

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OVERLAND WIRELESS TELEGRAPHY.

IN our March issue we referred editorially to the work of the American de Forest Wireless Telegraph Co., at Key West. Through the courtesy of that company we are now able to give a view of the station there. The illustration (see p. 445), shows the three masts of a 35 k.w. wireless telegraph station, erected at Key West for the United States Navy. Power is generated in the Government machine shop from a 50 h.p. steam engine, driving a 60-cycle, 110-volt generator. The station house is located in the middle of the triangle, and three screen of antennæ wire, each 300 ft. in length, run up from the station house to horizontal cables, stretched between the tops of the three masts. These masts are 210 ft. high and 300 ft. apart. The operation of the station has been exceedingly satisfactory. Messages have been exchanged with Chicago, 1450 miles (mostly overland), and with Kansas City and Cleveland, and other long-distance stations where the De Forest Co. has stations. This station is one of five which are being built for the Navy, three of the others being exactly like this, located at Panama, Porto Rico, Guantanama. The fifth station, at Pensacola, has two masts, and is equipped with 10 k.w.

Telegraphy Correspondence Class.—IV.

Conducted by CICERONE.

OWING to the extended dimensions of last month's instalment, the following notes, bearing upon the third exercise paper, were unavoidably crowded out. They will, perhaps, still be of service to some of those who are following the course of these lessons, and may assist them in their studies.

In estimating the resistance or length of wire for a coil or bobbin, several irregular factors have to be taken into account, for absolute accuracy, such as thickness of insulation, allowance for slack, &c., but for general purposes

$$L = \frac{\pi h(R^2 - r^2)}{d^2}$$

where π = 3.1416;
L = length of wire;
h = length of bobbin between cheeks;
R = outer radius of bobbin;
r = inner radius of bobbin;
d = diameter of covered wire.

The electrostatic capacity of a conductor depends upon its superficial area—that is, its length and diameter. A guttapercha-covered cable has a capacity usually of .3 microfarads per mile, an overhead line has only about a twentieth of this value; depending of course upon the thickness of the wire, or the amount of surface exposed to an electrostatic charge, and its distance from other conducting surfaces or the earth. This property is independent of the material composing the wire. The charge Q depends upon the capacity K of the conductor and the potential V applied to it, or $Q = KV$.

Wires used for telegraphic and telephonic purposes are usually referred to by their weight per mile, and this is the best method, as wire is purchased, transported, and distributed along the line by weight. Its breaking strain is proportional to weight. Its resistance varies inversely as the square of the diameter, which is also a function of its weight. Weight is invariable in all temperatures and in all latitudes. Multiples of a unit of weight are therefore the natural wire gauges.

Resistance and weight depend upon length, L, area of cross-section, A, and the material composing the conductor.

$$W = LA \quad . \quad . \quad . \quad . \quad . \quad (1)$$

$$A = \frac{W}{L} \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$L = \frac{W}{A} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

But $R = \frac{L}{A}$

Therefore, substituting (2)

$$R = \frac{L}{\frac{W}{L}} = \frac{L^2}{W}$$

If two wires have the same weight, their resistance varies as the square of their respective lengths.

The weight per mile and resistance per mile is a constant K for any metal. For iron it is 5,400 and for copper 890. To ascertain the resistance per mile divide this quantity by the weight per mile of the material thus: k for copper = 890. Weight per mile 200 lbs.

$$R = \frac{k}{w} = \frac{890}{200} = 4.5 \text{ ohms per mile nearly.}$$

"Prober" produced some excellent answers to the first set of questions, some of which, had the Colonial mail not delayed them beyond the time of going to press, would have been quoted. He has, however, been listed amongst our leading competitors along with "Nephalist," who has made a promising start, and also "Switchroom," whose answers show a high standard of excellence. Errors have creeped in here and there in their papers, but the writers will each, ere now, have detected them, and made note of the corrections pointed out to others. Now that the class is in full swing, and the period for submitting answers extended they should make an endeavour to keep up to time.

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The second set of questions has brought forth a number of excellent answers; but, as is usual where arithmetical and mathematical questions are involved, there are the customary crop of slips of the pen, &c. Ohm's Law, which expresses the relationship between current resistance and E.M.F. has been well defined by nearly everyone, but perhaps "Pelmar" best combines succinctness with accuracy in this way:

"The current flowing through a conductor is directly proportional to the difference of potential between the ends of the conductor, and inversely proportional to the resistance of the conductor."

"Dielectric" goes one better by saying: "The steady current," &c., because the law without some modification is not true for alternating, pulsating, or undulating currents.

The other moiety of this question, although correctly attacked by the majority of competitors, proved something of the nature of a pitfall to many others.

"Pelmar" again must be credited with neatness and accuracy, but "Treyar" is more explanatory. The former would best please some examiners, while the latter would best please others. Taken together, they may tend to make the problem clear to those who may be hazy on the matter. Both, therefore, are quoted.

"Pelmar's" answer is as follows:

Resistance of distant half of line = 1250Ω.
" leak = 1000Ω.

Line takes 15 m.a.

∴ Leak will take $\frac{1250}{1000}$ of 15 = 18.75 m.a.

∴ Total current required = 33.75 m.a.

Total external resistance

$$= 1250 + \frac{1250 \times 1000}{1250 + 1000} = 1806\Omega.$$

Number of cells required

$$= \frac{33.75 \times 1806}{2100 - (33.75 \times 3)} = 31 \text{ cells.}$$

"Treyar" solves the problem in this way:

"The current required at the distant end is 0.015 ampère, so that the *total* current necessary to give this owing to the leak must be *greater* than 15 mas. Call it X. At the fault the current will split in inverse proportion to the resistances, that is as 1000 : 1250, or as 4 : 5. This will mean that $\frac{5}{9}$ths of the *total* current in the circuit being lost *viâ* the 1000Ω leak must be allowed for in order to have 15 ma passing through the instrument at the distant end.

$$x - \frac{5}{9}x = 0.015$$
$$\frac{4}{9}x = 0.015$$
$$x = 0.3375$$

say, 34 ma. as the total current required throughout the circuit.

$$\frac{2.1n}{3n + 1806} = 0.034$$
$$2.1n = 0.102n + 61.404$$
$$n = 30.7$$

Answer 31 cells."

From the foregoing replies, all those who have forgotten about the leakage through the fault at the centre of the line will be able to amend their answers and make the necessary calculations.

The second question has been correctly answered by all but a few, who have fallen into slight errors which they will no doubt correct from the following:

$$H = C^2 R t \times .24$$
$$C = \frac{E}{R} = \frac{5}{10} = .5 \text{ amp.}$$

$$\therefore \quad H = .5^2 \times 10 \times 10 \times 60 \times .24 = 360 \text{ calories.}$$

The second half has been equally well done, but "Treyar" has taken a broader view of the question than any of the other competitors. He says:

"If the voltage remain constant the amount of heat will be reduced by half, but if the current be halved by reducing the voltage instead of increasing the resistance, then the amount of heat will be reduced to one quarter."

To prove this will form an interesting exercise for those who have any dubiety on the point.

The mode of grouping thirty Leclanché cells of 1.6 volts and 1.5 ohms each in order that the current through an external circuit of 50 ohms will be approximately the same as that from ten bichromates of 2.1 volts and 3 ohms each, as required by the third question has brought forth a number of diverse answers.

"Treyar" has fallen into the mistake of working it out from the formula $n = \sqrt{\frac{TR}{r}}$ which gives the number of cells for producing the maximum current. This, of course, is not exactly what is wanted. It is the number of Leclanché cells that will equal in current a certain number of bichromate cells of particular voltage and resistance through a circuit of 50 ohms.

First ascertain by Ohm's law the current from 10 bichromate cells.

$$C = \frac{E}{R} = \frac{10 \times 2.1}{(10 \times 3) + 50} = \frac{21}{80} = .262 \text{ ampere.}$$

Now you are required to find the number of Leclanché cells that will approximate this current.

This may readily be found by calculating the external voltage V required, and dividing by the available voltage per cell:

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$$V = CR = .262 \times 50 = 13.1 \text{ volts,}$$

and the number cells,

$$n = \frac{CR}{e - Cr} = \frac{13.1}{1.6 - (.262 \times 1.5)} = 11 \text{ cells nearly.}$$

So that they would have to be grouped in two rows of fifteen each, from which current C,

$$C_1 = \frac{E}{R + r} = \frac{15 \times 1.6}{50 + \frac{15 \times 1.5}{2}} = \frac{24}{61.25} = .392 \text{ amp.}$$

or $.392 - .262 = .130$ in excess of the other case. All this has been very nicely expressed by a competitor in these words:

Total E.M.F of the 10 bichromates = 21 volts.

Nearest to this in Leclanché's is $\frac{21}{1.6} = 13$ cells.

Nearest factor of 30 = 15. Therefore, two rows of 15 cells each, which would give

$$\frac{15 \times 1.6}{\frac{15 \times 1.5}{2} + 50} = 392 \text{ m.a.}$$

Continuing the second part of the question, the same student says:

"The current from 10 bichromates (2.1 volts and 3 ohms per cell) in series through 50 ohms = 262.5 m.a. From Leclanché's grouped as above we get 392 m.a.

Total resistance (in case of Leclanché) $= \frac{15 \times 1.5}{2} + 50 = 61.25$ ohms.

Let X be resistance required to reduce current to 262.5 m.a., then

$$\frac{240}{61.25 + x} = 262.5.$$

$$\therefore \quad x = 30.17 \text{ ohms.}$$

It may simplify matters to younger students if the latter question is shown in another way.

It is required to produce a current of .262 ampere in a circuit having a pressure of 24 volts (*i.e.*, 1.6 × 15), and in which there is a total resistance of 61.25 ohms:

$$R = \frac{E}{C} = \frac{24}{.262} = 91 \text{ ohms nearly.}$$

There being only 61.25 ohms in circuit, there will require to be added

$$91 - 61.25 = 30.75 \text{ ohms nearly.}$$

"Dielectric" has answered these questions very well, but he will observe from the above that he has fallen into error on one or two points.

The calculation of the quantity of zinc consumed in a battery of 20 cells in which a current of 0.115 amp. flows for 30 minutes, and in which 0.045 oz. of zinc per cell is consumed per ampere-hour, has been done correctly by nearly all competitors.

"Nipper" puts it this way:

$x = ctnQ = .115 \times .5 \times 20 \times .045 = .051$ oz.,

where c = current.

t = time in hours.

n = number cells.

Q = quantity consumed per ampere-hour.

The effect of an increase in temperature would be to decrease the resistance and increase the E. M. F. of the cells slightly, so that there would be a resultant increase in the consumption of zinc.

The next question has been answered in two ways: some including an internal resistance of 10 ohms in the battery, and others omitting this in their calculations. Both are right from their respective standpoints.

From the former class the following is a good specimen:

$$\text{Total resistance} = \frac{1}{10} + \frac{1}{15} + \frac{1}{20} + 10 = 14.6 \text{ ohms.}$$

$$\text{Total current} = \frac{E}{R} = \frac{50}{14.6} = 3.421 \text{ amps.}$$

This current divides in inverse proportion to the resistances of the three circuits, *i.e.*,

In the 10 ohm wire $\frac{6}{13}$ of $3.421 = 1.579$ amp.

„ 15 „ $\frac{4}{13}$ „ $= 1.053$ „

„ 20 „ $\frac{3}{13}$ „ $= 0.789$ „

From the latter class the following is one of the best:

"If no battery resistance to consider each line would take same current as it would if acting alone, viz.: $\frac{50}{10} = 5$ amps; $\frac{50}{15} = 3\frac{1}{3}$ amps; $\frac{50}{20} = 2\frac{1}{2}$ amps. respectively.

$$\text{Joint resistance} = \frac{1}{\frac{1}{10} + \frac{1}{15} + \frac{1}{20}} = \frac{300}{65} \text{ ohms.}$$

$$\text{Current} = \frac{50}{\frac{300}{65}} = \frac{65}{6} \text{ amps.}$$

Therefore, current through

$$10 \text{ ohms.} = \frac{\frac{65}{6}}{30} = 5 \text{ amps.}$$

$$15 \text{ ohms.} = \frac{\frac{65}{6}}{20} = 3\tfrac{1}{3} \text{ amps.}$$

$$20 \text{ ohms.} = \frac{\frac{65}{6}}{15} = 2\tfrac{1}{2} \text{ amps.}$$

} as before.

With 10 ohms. in battery the current is:

$$\frac{50}{10 + \frac{300}{65}} = 3\tfrac{8}{19} \text{ amps.}$$

Therefore volts lost in battery:

$$3\tfrac{8}{19} \times 10 = 34.21 \text{ volts."}$$

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Another competitor answers the latter part of that question thus:

"If the battery resistance is 10 ohms and the external resistance is 14.6 ohms, then $\frac{10}{14\cdot6}$ of the total voltage is lost in the battery = 34.2 volts."

The first half of the final question has been answered correctly by nearly all, and a good many have mastered the second moiety as well; but others have gone far astray, while a number have not attempted it at all.

The current in a line of 30 ohms from 12 cells of 2 volts and 10 ohms in series

$$=C\,\frac{E}{R}=\frac{12\times2}{(12\times10)+30}=\frac{24}{150}=.16 \text{ amp.}$$

and from eight cells joined four in series and two in parallel

$$C=\frac{2\times4}{\left(\frac{4\times10}{2}\right)+30}=\frac{8}{50}=.16 \text{ amp.}$$

So that the current is of the same strength in both cases.

Most students have found it much more difficult to find the greatest resistance that a battery may have, so that the current will not in any case vary more than 25 per cent. in six parallel circuits of 500 ohms each. From the correct solutions the following two are selected:

Current from 1 circuit working alone $=\frac{E}{500+x}$

" " 1 " when all working $=\frac{E}{\frac{\frac{500}{6}+x}{6}}$

Current in second case must not be less than 75 per cent. of that in first case.

$$\frac{\frac{E}{\frac{500}{6}+x}}{\frac{E}{500+x}}=\frac{75}{100}$$

$$\therefore\ \frac{500+x}{500+6x}=\frac{75}{100}$$

$x=35.7$ ohms."

The second brings the same answer in a different way:

"When only one circuit working $C=\frac{E}{R+r}$.

When the six are working together, C in each wire

$$=\frac{E}{\frac{R}{6}+r}\times\frac{1}{6}=\frac{E}{R+6r}$$

Now $\frac{E}{R+r}-\frac{E}{R+6r}$ must not vary more than $\frac{E}{R+r}\times\frac{25}{100}$.

$$\therefore\ \frac{E}{R+r}-\frac{E}{R+6r}=\frac{E}{R+r}\times\frac{25}{100}=\frac{E}{R+r}-\frac{E}{R+r}\times\frac{1}{4}=\frac{E}{R+6r}$$

$$\left(\frac{E}{R+r}\right)^{(1-\frac{1}{4})}=\frac{E}{R+6r}$$

$r=35.713$."

The electrostatic capacity of a conductor, upon which several of the fourth set of questions are based, is the power of retaining or accumulating a charge or quantity of electricty upon its surface. If a wire, insulated at one end, has its other end connected to a battery, or some other source of electromotive force, whose opposite pole is earthed, the whole wire will assume the same potential as the pole to which it is attached, and a potential difference will exist between the wire and the earth, or any other conducting surface in its neighbourhood. The wire is now said to be excited, charged, or electrified, and may be regarded as an elongation of the pole to which it is attached. The positively charged wire appears to have the effect of polarising or electrifying the molecules of the air, or other insulating medium, and by the law that "like electricities repel and unlike attract," the molecules arrange themselves in polarised chains across the medium, the negative ends being turned towards the positively charged wire, while the positive ends are repelled in the opposite direction. This phenomenon, which manifests itself very strongly under a high electrical pressure in the insulating material of cables, is sometimes called electrification, and it invariably manifests itself in the medium surrounding an electrostatic charge. It continues as long as the positively charged wire, or inducing conductor, remains in the vicinity, but when it is removed or discharged the strain in the medium is relieved, and a normal condition is then assumed. The farther removed from the charged body, the less intense is the *influence*, or *electrostatic induction*, as this action on other bodies is called. It diminishes as the square of the distance, and in regions above an overhead wire it is scarcely felt at all, the earth itself attracting the streamers from the surface of the wire downwards. The medium where these actions take place is called the dielectric. All dielectrics are insulators, but good insulators may not be equally good dielectrics. The power of the dielectric to allow an electrostatic charge to influence other bodies across it, is called *dielectric capacity, inductivity*, or an older term, *specific inductive capacity*. It is least in dry air, and greatest

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in mica and some qualities of glass. Guttapercha, indiarubber, and paraffin wax are other good dielectrics.

In calculating the capacity of overhead lines, subterranean and submarine cables, condensers, &c., this quality is of transcendental importance.

The electrostatic capacity of a line, then, depends not only upon its superficial area, or amount of surface presented to the charging source, but also upon the dielectric capacities of the circumambient medium. In air at a temperature of 0 C., this quantity is taken as unity, and the values for other materials have been measured in a variety of ways, by several investigators, but with widely different results. These values will be found tabulated in any good text book on electricity. It will suffice for our purpose here if it is mentioned that the inductivity of glass ranges from 6 to 10, according to its density, mica from 5 to 8, guttapercha and indiarubber about 2.5, the only media having a slightly lower inductive capacity than air being vacuum and hydrogen, which are each evaluated, approximately, at 0.999.

Although the nature of the material composing the conductor has no direct effect upon electrostatic capacity, it has indirectly, in so far as for a given length and a given resistance a material of high conductivity would present a smaller area than one of lower conductivity. Copper, for instance, having a resistance of about one-seventh that of iron, could be made so much thinner for a given length and a given resistance.

Briefly, then, the electrostatic capacity K of a conductor depends directly upon the surface area of the conductor, and upon the dielectric capacity of the medium separating it from another conducting surface, and inversely as the distance separating the two conductors.

For an overhead wire $K = \frac{l\,d\,s}{4h}$

Where l = length of wire
d = diameter of wire
s = dielectric capacity
and h = height above the ground.

As the dielectric is air, s may be neglected.

For two parallel wires $K = \frac{l\,r\,s}{D}$

Where r = the radius of wire
D = the distance of wires from centre to centre.

For underground cables $K = \frac{l\,s}{\log \frac{D}{d}}$

Where $\frac{D}{d}$ = the ratio of the external diameter of the insulator to that of the enclosed conductor.

It will be seen that K for an underground line is much greater than that on an overhead system, since guttapercha has about three times the dielectric capacity of air, and the thickness of the insulating material in a cable is so much less than the thick stratum of air surrounding an aerial line. One mile of cable of average dimensions has a capacity equal to about twenty miles of overhead line.

The unit of capacity is called the Farad, but for practical purposes the microfarad, or one-millionth of the value of the unit, is used. Three miles of the Atlantic Cable has one microfarad, sixty miles of average land has also one microfarad, while the cable from Ballins-kelligs to Nova Scotia possesses 992 microfarads, being about 290 microfarads more than that of the earth itself as an isolated sphere.

The capacity of any number of condensers joined in parallel is equal to the sum of their respective capacities, but the capacity of any number joined in *cascade* or series is only equal to the reciprocal of the sum of the reciprocals of the several condensers. The capacity K of two condensers K_1 and K_2 connected in cascade $= \frac{K_1\,K_2}{K_1 + K_2}$, and the capacity, K_2, of a second condenser, when the joint capacity, K, of itself, and another K_1 is known $= \frac{K_1\,K}{K_1 - K}$

On this subject students are referred to "Modern Views of Electricity," by Dr. Lodge, and to Foster and Atkinson's translation of Joubert's "Electricity and Magnetism."

In addition to the formula given above for ascertaining the length of wire required to fill a bobbin of specific dimensions, the following will also be found useful:

$$n = \frac{R - r}{d}$$

$$N = \frac{h\,(R - r)}{d^2}$$

$$W = \frac{k\,h\,(b^2 - a^2)\,d^2}{D^2}$$

$$R = \frac{k\,h\,(b^2 - a^2)}{D^2 \times d^2}$$

Where n = number convolutions in one section.
N = number convolutions on bobbin.
W = weight in lbs.
R_1 = resistance in ohms.
R = outer radius of bobbin.
r = " " " core.
b = outer diameter of bobbin.
a = diameter of bobbin core.
D = diameter of covered wire.
d = " bare wire.
h = length between checks.
k = a constant depending upon the metal.

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EXERCISE IV.—MAY, 1905.

1. (*a*) Define clearly electric potential, unit quantity of electricity, electrostatic induction, dielectric capacity, and electrostatic capacity.

(*b*) What quantity of electricity resides on the surface of a conductor having a capacity of 10 microfarads when it is charged to a potential of 50 volts?

2. (*a*) What is the electrostatic capacity of an overhead wire 200 miles in length, 180 mils in diameter, and 20 ft. above the ground if twenty miles of wire of half that diameter and 12 ft. above the ground has a capacity of 1 microfarad?

(*b*) To what height would the latter have to be raised to reduce its capacity by 50 per cent.?

3. (*a*) Three condensers, of 2, 5, and 10 microfarads respectively, are first joined in parallel, and then in cascade. What are the capacities of the two separate combinations?

(*b*) A condenser of 20 microfarads is joined in cascade to a second one of unknown capacity. The combination has 10 microfarads. What is the capacity of the second condenser?

4. (*a*) A guttapercha insulated cable, 500 miles long, having an internal and external diameter of 50 and 100 mils respectively, has a capacity of 150 microfarads. By how much will the capacity be reduced if a dry paper-covered cable of the same length, but of 50 and 55 mils diameter respectively, is substituted?

(S for guttapercha = 4 and for air = 1.)

(*b*) What is meant by electrification?

5. (*a*) Explain, either graphically or in words, how it is that a line, when insulated at one end, will contain twice the quantity or static charge that the same line will take when it is earthed at the distant end?

(*b*) Compare the capacity of an overhead line 250 miles in length, 50 mils in diameter, suspended at an average height of 25 ft., with that of an equal length of cable, the external diameter of the insulating material being 120 and that of the enclosed conductor 50 mils.

6. (*a*) Find the weight of copper wire (20 mils in diameter and a diameter of 30 mils over the silk covering) on a bobbin measuring 6 ins. between the flanges or cheeks, 4 ins. outer, and 1 in. inner diameter of bobbin ($k = .25$).

(*b*) Calculate the resistance and the number of convolutions on the same bobbin? ($k = .00000085$).

Special Prize Scheme for Telegraph Students.

As an inducement to Telegraph Students to join our Correspondence Class, we have decided to offer the following prizes for the best sets of questions sent in, in order of merit:—

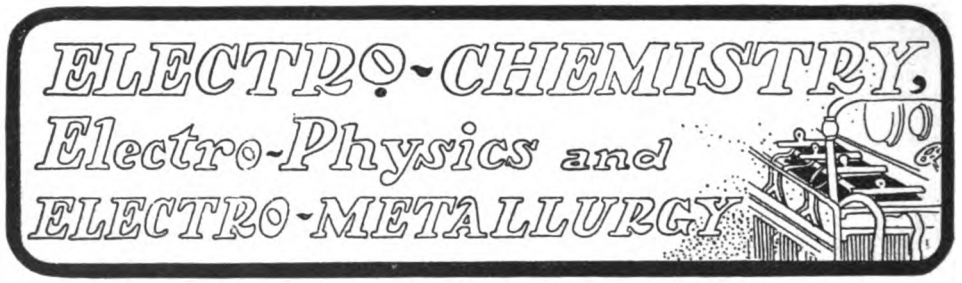
1st Prize, Goods to the value of £10.
2nd „ „ „ £5.
3rd „ „ „ £2 10s.

Orders to these amounts will be handed the successful competitors upon the following firms, particulars of whose products will be found in our advertisement columns:—

DARTON & CO. — H. W. BEDFORD & CO.
A. G. THORNTON. — W. H. HARLING.
THE NATIONAL PHONOGRAPH CO. — R. NICHOLL.

Additional Prizes of smaller amounts will be awarded if the scheme is well supported. The time of distribution will be announced later.

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Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

The N-Ray Mystery.

(Special Article.)

By J. GARCIN.

THIS brief serial on N-ray phenomena is not written with any intention to take up the cudgels in defence of some particular theory on a matter which has lately been exciting so much controversy. The writer has set himself the humbler task of placing before the British public a clear and impartial compendium of facts which will enable the reader to form his own opinions on the subject, and control them by original and personal experiments. For though the nature and origin of N-rays may still be said to be wrapped in mystery, yet the phenomena which reveal their presence are of the simplest possible kind, requiring no special scientific apparatus for their production. If the N-rays have any real objective existence, then any one has it in his power to conjure them forth from their hiding-places and bid them reveal their secrets, and as the searcher has a vast field before him, who knows but that he may be instrumental in bringing to light some new and valuable discovery? Even should he not succeed in this, still the study of such mysterious radiations will amply repay the effort required, which calls for all the mental and moral faculties of the observer, and constitutes an invaluable scientific training.

The universal interest which has centred on N rays ever since the date of their presumed discovery may be traced to several reasons, some of which have perhaps no direct connection with pure natural philosophy. Many critical inquirers in this domain appear to be hoping for the advent of some new discovery which will upset one of the dogmas of Science, or afford some confirmation of their own dreamy theories. Even renowned physicists have of late been drifting, unconsciously perhaps, into metaphysics. The author, however, will not indulge in such pleasant speculation, but will confine himself to stubborn facts and let others be responsible for philo- or theosophical interpretations. To begin with, a short historical account of the discovery may be of interest. Early in March, 1903, M. Blondlot wrote to the French Academie describing some experiments which seemed to prove that X-rays were polarised from the moment of their emission by a focus tube. The term polarisation used in connexion with X-rays would imply that out of the infinite number of planes which can be drawn containing an X-ray, one of these may be selected in which the ray exhibits peculiar properties. In other words the ray has "sides differing from each other," according to Newton's definition. In a second communication, M. Blondlot announced that the radiations he had been studying were not only plane-polarised, but exhibited all the properties of light (save visibility) being susceptible of regular and double refraction and also reflection. These facts showed that he had not been dealing as he thought with X-rays, since the latter undergo neither refraction nor reflection. In fact, a new species of light stood revealed, which penetrated aluminium, black paper, wood, etc., was refracted, reflected, and diffused, and, further, was susceptible of rotatory and elliptic polarisation, but produced neither fluorescence nor photographic action. Here, then, was a new field of research. Starting from this discovery, M. Blondlot pushed his experiments further and found that these

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rays, which he called N-rays after the town of Nancy, in whose university he is professor, were emitted by Nernst lamps, incandescent gas burners, strips of platinum heated to a red heat, tempered steel, Prince Rupert's drops, and in general substances in a state of strain or compression. He next measured their wave-length, which he found was smaller than the shortest ultra-violet rays yet known. They would probably, therefore, have for ever escaped detection were it not for their property of increasing the light of a small electric spark or other feebly luminous source of high actinic power, or again a phosphorescent screen previously exposed to light for a short time. Such means of verification were so evidently subjective that only too naturally M. Blondlot set about to find some more reliable proof, and as early as February in last year he announced to the Academie that the increase in glow of a small electric spark when under the influence of N-rays could be registered by photography. A report on this communication will be found in one of the back numbers of this magazine. Objective evidence of this kind appeared sufficient at the time to assign to N-rays a definite place amongst other real phenomena which are actually under study.

Meanwhile, however, other physicists who read M. Blondlot's first communication had not remained idle. The matter was being investigated simultaneously in a great many laboratories in Europe, and although some lucky searchers seemed endowed from the outset with the faculty of "seeing the rays" or rather detecting the phenomena excited by their presence, the majority failed to obtain very appreciable results. Then, of course, the usual re-action set in. Foreign workers, amongst whom we may name Professor Lummer, of Berlin, sent in communications stating that they had been unable to reproduce M. Blondlot's experiments. Professor Rubens, to whom it is alleged that the German Emperor intimated an order to produce the N-rays for Imperial inspection within twenty-four hours, took advantage of the Cambridge meeting of the British Association to express his scepticism and called for a poll of the audience, when it was found that only one out of fifteen present had been successful in obtaining ocular evidence of the increase of light observed by M. Blondlot. Later, the wave of re-action seems to have reached French scientific circles, many physicists openly avowing their disbelief. The fact that the French Academie had awarded a prize of 50,000 francs to M. Blondlot for, amongst other things, his researches on N-rays, only served to embitter the opposition, in which it may be said that international and professional jealousies have played no inconsiderable part. The unreserved negation by some physicists may also have been provoked by the attempts made by the Spiritualists and certain followers of the well-known School of Nancy, to interpret the phenomena after their own manner, and make capital out of the affair. Though the case cannot, therefore, be considered satisfactory from M. Blondlot's point of view, yet his reputation as a physicist of the first rank and an experimenter of great skill and sagacity, as well as the names of the great savants who have endorsed his views are weighty arguments in his favour.

(*To be continued.*)

Types of German Testing Instruments.

By DR. ALFRED GRADENWITZ.

OUR Continental friends—the Germans—have a world-wide reputation for accuracy, consequently considerable interest attaches to the many excellent types of electrical instruments manufactured by them for laboratory purposes. At the recent Jubilee of the German Electrical Society, an Exhibition was held, and one of its special features was the representative collection of instruments of precision, placed on view by the more important makers of such instruments. A brief



FIG. 1.

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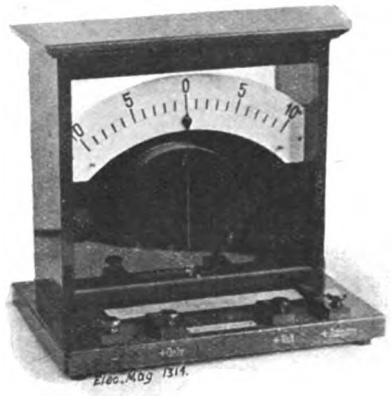


FIG. 2.

review of these types is given in the following article.

A precision galvanometer of the Deprez d'Arsonval system, exhibited by Messrs. Gans and Goldschmidt, Berlin, with thread suspension and index (Fig. 1) should be especially suitable for laboratories, on account of its extreme sensitiveness. The sensitiveness of the 100 ohm range instrument is 2:10,000,000 ampère for deflections of one degree; this instrument thus affords an accuracy of one 1000th when connected to the Wheatstone bridge or to a compensation apparatus.

The precision school galvanometer, with a scale visible at a distance (Fig. 2) has been designed, as a milliampèremeter up to 10 milliampères, to be adjusted for 50 ampères at 250 volts. The firm further exhibited a graphite resistance of 500 megohms with a constant accuracy of 2 per cent.

Two instruments of especial interest for glow lamp manufacturers were also exhibited. The relay contact ampèremeter, represented in Fig. 3 is used for preparing carbon filaments. The carbonised filaments are exposed in an atmosphere of heavy hydrocarbons within a glass receiver, *f*, after which they are traversed by the current, a contact ampèremeter, *a*, being inserted in the circuit. The thinnest portions of the wires will obviously first become incandescent, when, owing to the reduction of the gases, solid carbon is deposited on their surface After the wire has become of uniform section throughout its length, its diameter will increase at a uniform rate during the incandescence. This apparatus is more suitable than the bridge arrangement frequently used in the preparation of carbon filaments, as it does not respond to a given resistance of the filament, but is independent of the lamp tension and of the length of filament for a given cross section. The apparatus can also be provided with a division according to diameters of filament, so that even unskilled operators may attend to the apparatus. A direct-reading ohmmeter, which was likewise exhibited, and the scale of which is divided into diameters, allows of the ready prepared filaments being checked with one another as to their diameters.

The compass transmission device exhibited by Messrs. Siemens and Halske, is based on the bolometric principle, and works without relay. The primary compass resembles the ordinary type of compass in use on board German ships. The rose is of the Kaiser type, which, on account of the magnets being located at the periphery is highly suitable for the purpose. To the rose is connected a mica plate coated with tinfoil. The latter contains a horn-shaped aperture through which the rays from a strong glow lamp, placed above, strike the bolometric device situated below the movable rose. According to the position of the latter, different parts of the bolometric grating will be radiated on, and this radiation results in alterations of the resistance, producing variations of current in the constant resistance arrangement connected to the grate, which, in turn, causes the rose of the secondary compass to take up the same position as that of the primary compass. The electromagnet of the secondary compass as well as the glow lamp and bolometric outfit receive their current from the direct current plant of the vessel. Any variations of pressure of the latter will not influence the accuracy of transmission.

The secondary compass consists of a measuring instrument of the Deprez d'Arsonval type, having a horse shoe electromagnet.

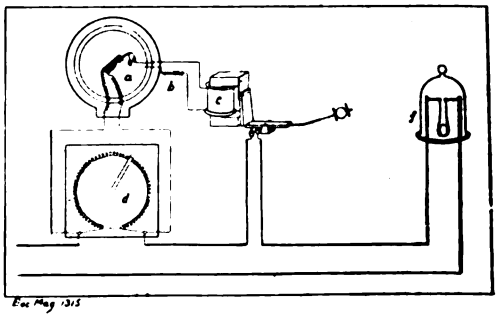


FIG. 3.

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The movable coil of the latter contains two windings, exerting a differential action, being traversed by currents, the intensity of which depends on the alteration in the resistance of the bolometric device in the primary compass. Rigidly connected to the movable coil is the rose of the secondary compass, a special device allowing of the rose performing entire revolutions, without injuring the conducting leads to the movable coils. The outfit further includes a switchboard, containing any necessary safety fuses, switches, measuring instruments, and terminals.

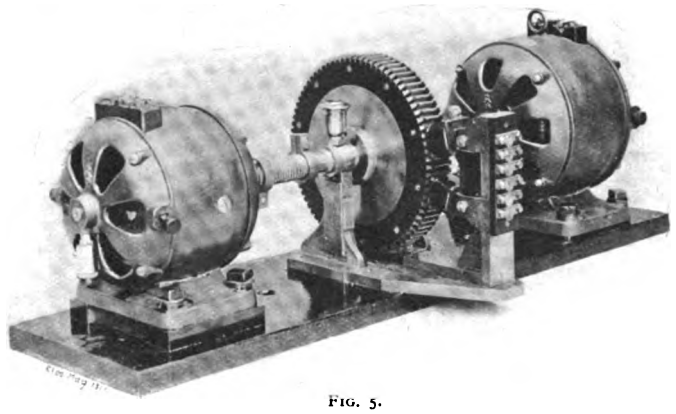


FIG. 5.

A similar transmission outfit, the transmitter of which can actuate simultaneously several receivers, was installed some years ago by the Dutch Navy on one of their armoured cruisers, the results being very encouraging, though the trial apparatus was the first ever built. The system has since been further developed and improved upon in many respects. Experiments made on board the German battleship "Württemberg," in 1903, gave highly satisfactory results, firing with large guns in the immediate neighbourhood of the apparatus, producing no disturbance in the readings.

The bridge outfit for direct and alternate currents of the Siemens and Halske to allow of self-inductions, being determined down to 0.001 Henry (10^6cm), while the bridge for determining small self inductions shown in Fig. 4 has the bridge wire stretched out in a straight line and reduced to 10cm. so as to avoid any errors resulting from mutual induction; instead of a ring of resistances a manganese wire 2cm. length and over which a sliding contact can be moved accurately, is being used.

This bridge enables even the smallest self-inductions down to 10^{-7} henry (100 cm.) to be measured with an accuracy as great as 1 to 2 per cent. The two bridges will allow also of coefficients of mutual induction being measured and of self-inductions being determined in absolute value according to the Wien methods.

For producing alternate currents of very high frequency the alternate-current generator represented in Fig. 5. is used. The essential part of this generator is a toothed iron disc, close to the teeth of which are placed the poles of a horseshoe electromagnet having three windings. These poles are sharpened like wedges, so that the magnetic circuit is closed by the iron disc as soon as the teeth of the latter come opposite the poles of the electromagnet. If the electromagnet be excited by direct current passed through the central windings and the disc be rotated rapidly by a motor, alternate currents will be generated in the secondary windings. With this machine alternate currents up to 10,000 periods per second can be generated. The second electromotor, seen to the left in Fig. 5, is closed by an adjustable resistance and serves to produce a constant load on the driving

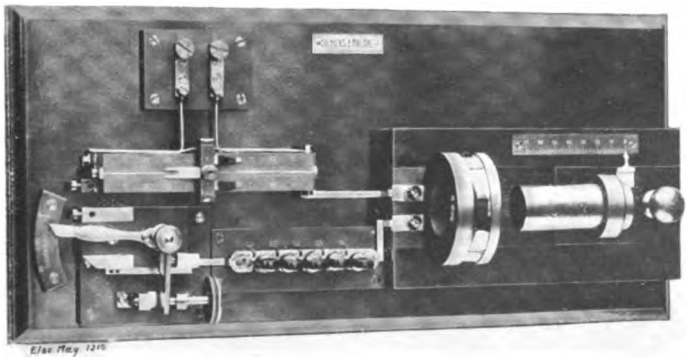


FIG. 4.

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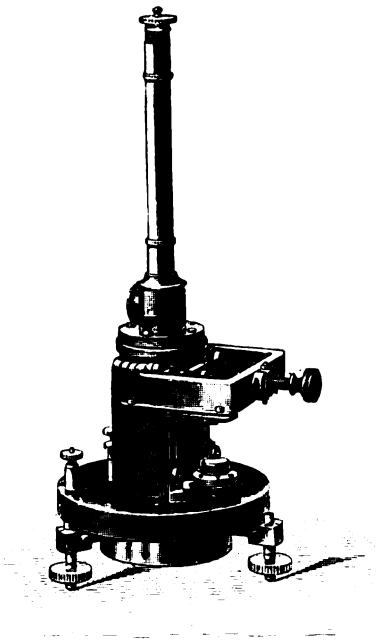


FIG. 7.

motor, so that small variations due to friction in the bearings, &c., do not influence the speed of the driving motor.

An electrometer of the Beggerow system, having two adjustable electrodes and a movable needle, was also on exhibit (Fig. 6). The needle consists of a very thin metal band, having a reading microscope with eyepiece micrometer, in an enclosed metal casing with amber and rock crystal insulation, and an air drying device with metallic sodium. The range of this instrument is from 0.1 to 50 volts with an auxiliary potential of about 300 volts.

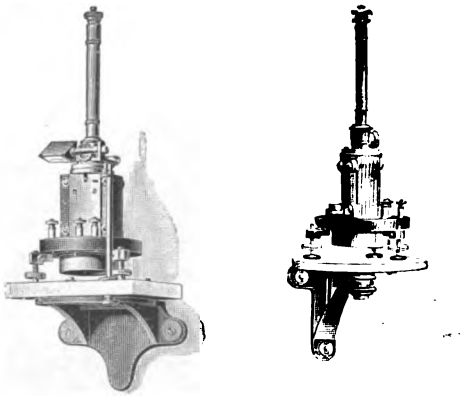


FIG. 8.

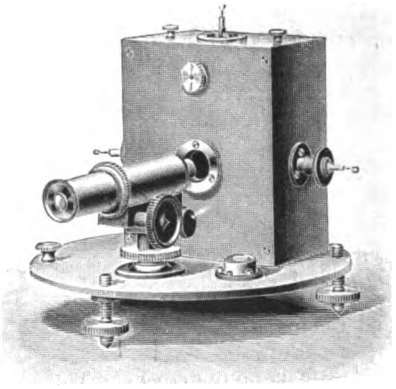


FIG. 6.

A mirror galvanometer of the Deprez-d'Arsonval system is represented in Figs. 7 and 8. This instrument has a movable coil oscillating in a strong magnetic field, its special features and advantages being as follows: The galvanometer deflections are proportional over wide limits to the current, on account of the perfect homogeneity of the magnetic field. The coil systems are light and readily exchangeable. The coil of the movable system has been fitted with a damping winding. For special purposes (ballistic measure-

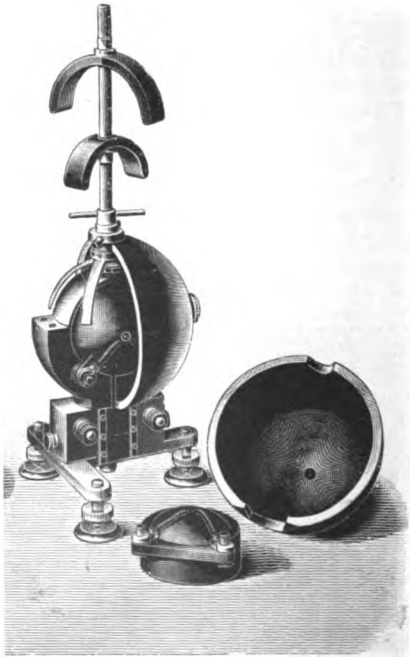


FIG. 9.

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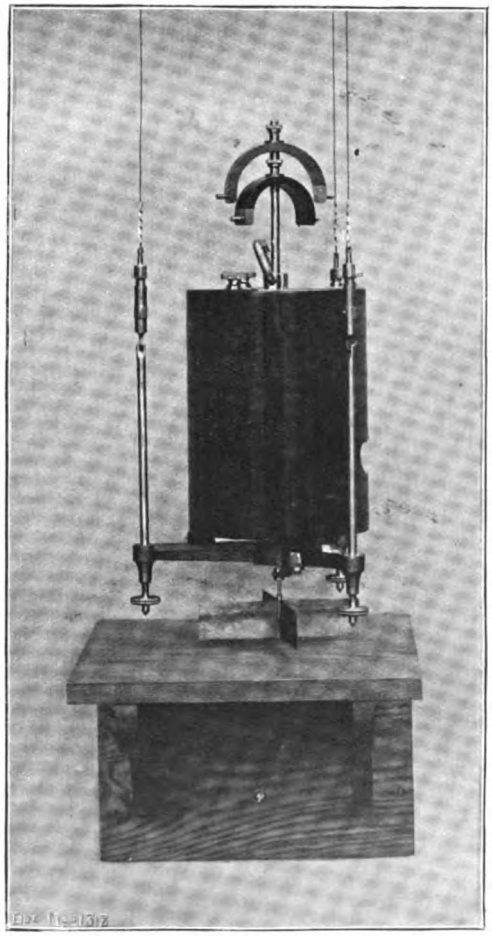


Fig 10.

ments) the movable system is weighted so as to obtain considerable oscillation with a small damping factor. By means of a magnetic shunt the resistance can be varied at will by about 35 per cent. The vertical reading device allows of the scale being placed in a convenient position and the index being well illuminated while occupying only a small amount of room; even in light rooms readings may be taken.

The spherical armoured galvanometer, shown in Fig. 9, has been designed on the Du Bois-Rubens system. In contradistinction to the above rotary-coil galvanometers, this "needle galvanometer" has stationary coils and a movable magnet system. By two concentric spherical armours and a third cylindrical armour designed as casing for transport, this galvanometer has ample protection against any outside magnetic disturbances, and it can be used to advantage in connection with scientific work wherever there are magnetic disturbances resulting from tramways, &c.

A convenient method of suspension is represented in Fig. 10. In order to avoid any influence of mechanical shocks, mirror galvanometers are installed on special devices. That represented in Fig. 13 is intended for the installation of the spherical armoured galvanometer, and readings are taken by means of telescopes.

The branch resistance according to Feussner exhibited by the Siemens and Halske Company comprises a millivoltmeter and a multiple step ammeter, allowing of the range being shifted at will to any one of the seven measuring ranges available, or else of passing to the short-circuit position without interrupting the current. It is thus possible to take readings with any strength of current in the upper range of the scale of the millivoltmeter, thereby increasing the accuracy. The actual scale factor is seen in big figures behind an aperture in the casing.

A Universal galvanometer which was on view will be seen in Fig. 11. This galvanometer constitutes a combination of a rotary coil instrument with a Wheatstone bridge, allowing of current strengths, E.M.F.s, battery and wire resistances up to 30,000 ohms being measured directly and faults located in circuits. An extension of the ranges of the instrument has been ensured by using the bridge outfit for measuring electrolytic resistances, with telephones as zero instruments, even with alternate currents.

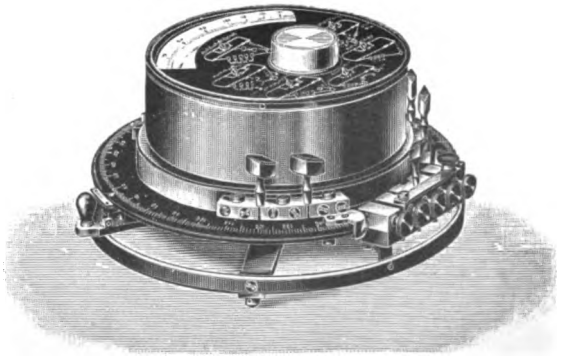


Fig. 11.

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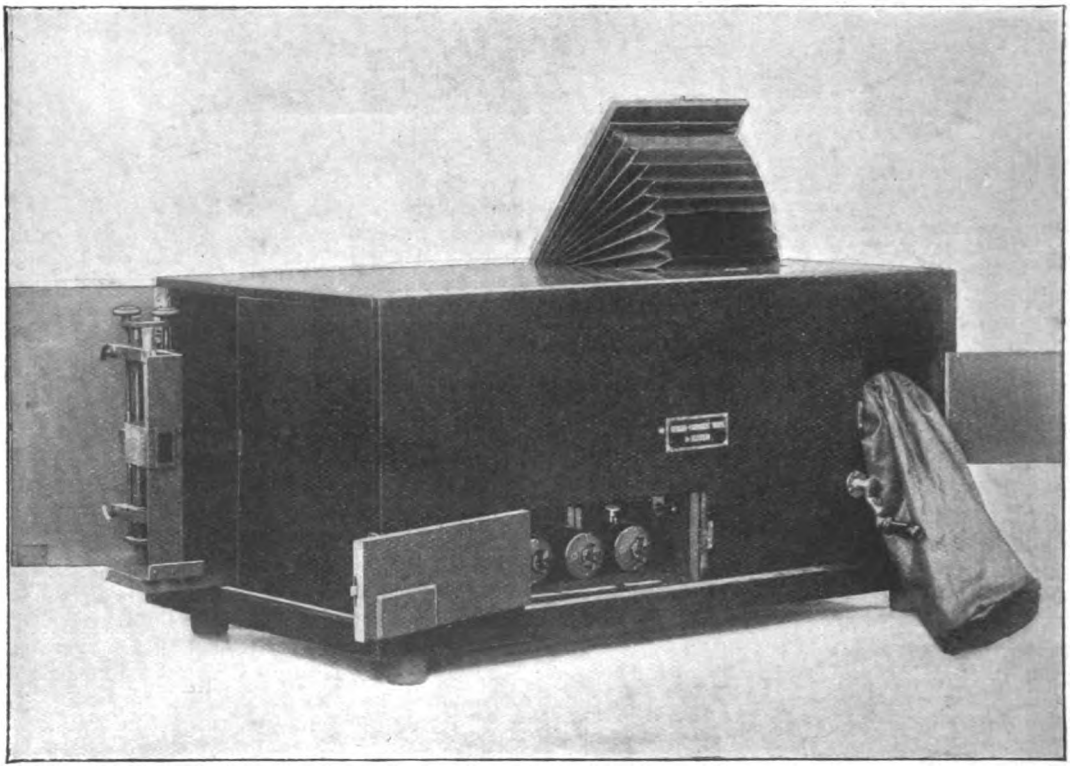
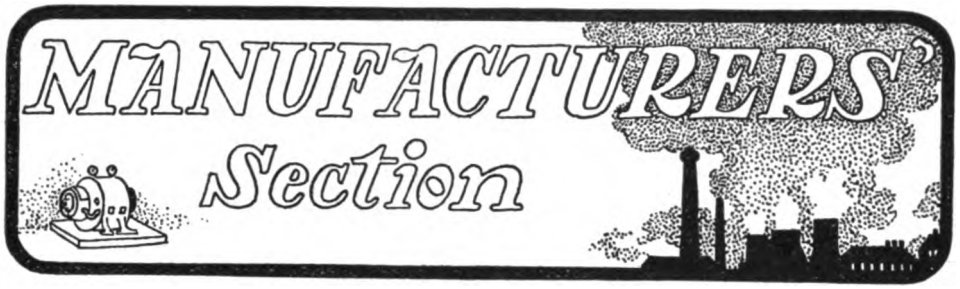


FIG. 12.

A universal measuring instrument for telegraph and telephone circuits similar to the above outfit is much used by the Postal and Telegraph Departments of many States. This universal instrument enables the following measurements to be performed: (1) Resistance measurement of individual conductors and double conductors, (2) insulation measurements of individual conductors from earth and double conductors from one another, (3) external current measurements in individual conductors, (4) determination of current strengths and potentials.

An oscillograph mainly agreeing with the Blondel type of apparatus was further exhibited (Fig. 12). This apparatus is a convenient device, allowing as it does of current diagrams being rendered visible immediately before their photographic record is taken, so as to enable the experimenter to fix by photography only the portion of the phenomenon that is of a special interest to him. The underlying principle is as follows: The oscillograph comprises a Blondel galvanometer, and the beam of light, caused by the galvanometer to perform vibrations corresponding to the shape of the curve, is thrown on a drum covered with sensitised paper. A synchronous motor drives the drum, and simultaneously the device for rendering the curve visible. Between the oscillograph and the photographic drum has been placed a mirror directing the light first on a rotary device and thus rendering the curve visible. By pressing down a button, this mirror is made to recede, when the beam of light will trace the curve on the drum.

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A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section at end of Magazine.

THE BRIGHTON WORKS OF THE REASON MANUFACTURING CO., LTD.



IN previous issues we have dealt in this section with the heavier branches of electrical engineering, but it must not be supposed that the making of dynamo electric machines constitutes the end and object of electrical manufacture. There are other sections of the art in which lighter though equally important articles need producing, and the same skill, method, and foresight must contribute towards the finished result as are now inseparable from the economical manufacture of the more bulky apparatus. The meters, fuses, arc lamps, and street lighting accessories common to central station service require organisation and concentration in manufacture as much as do motors and dynamos, engines and boilers. Under these circumstances we feel that the engineers of electricity supply stations will be interested in a brief description of the works of the Reason Manufacturing Co., Ltd., at Brighton, more especially as the great majority of them will be users of one or other of the various devices produced there. Familiarity is supposed to breed contempt, but in this case closer acquaintance will, we are sure, improve relationship. Like all business concerns, or anything else, for that matter, the Company has a history, but it differs from many records in that it tells of steady upward progress since the day it was first made.

The formation and subsequent expansion of the business are mainly attributable to the zeal and enterprise of the late Mr. Henry Reason, whose keen instinct correctly gauged the future scope and possibilities of the undertaking.

THE WORKS.

The present extensive buildings were erected on the outskirts of the town, after a practical trial of the inconvenience of having several branches detached, and consequently inconvenient, in a congested central district. In the old works in the town the space available was speedily overrun, and to cope with a constantly increasing demand nothing remained but to build new offices and shops. These premises, which were opened in 1901, are built to form the four sides of a square, there being a spacious quadrangle in the centre. All the shops are large, airy and light, and suitably arranged to facilitate manufacture with as little rehandling of parts as possible. Lighting is by arc and incandescent lamps, and motors driving lengths of shafting by belt furnish the necessary power for the various tools. Nothing of a very heavy nature is put

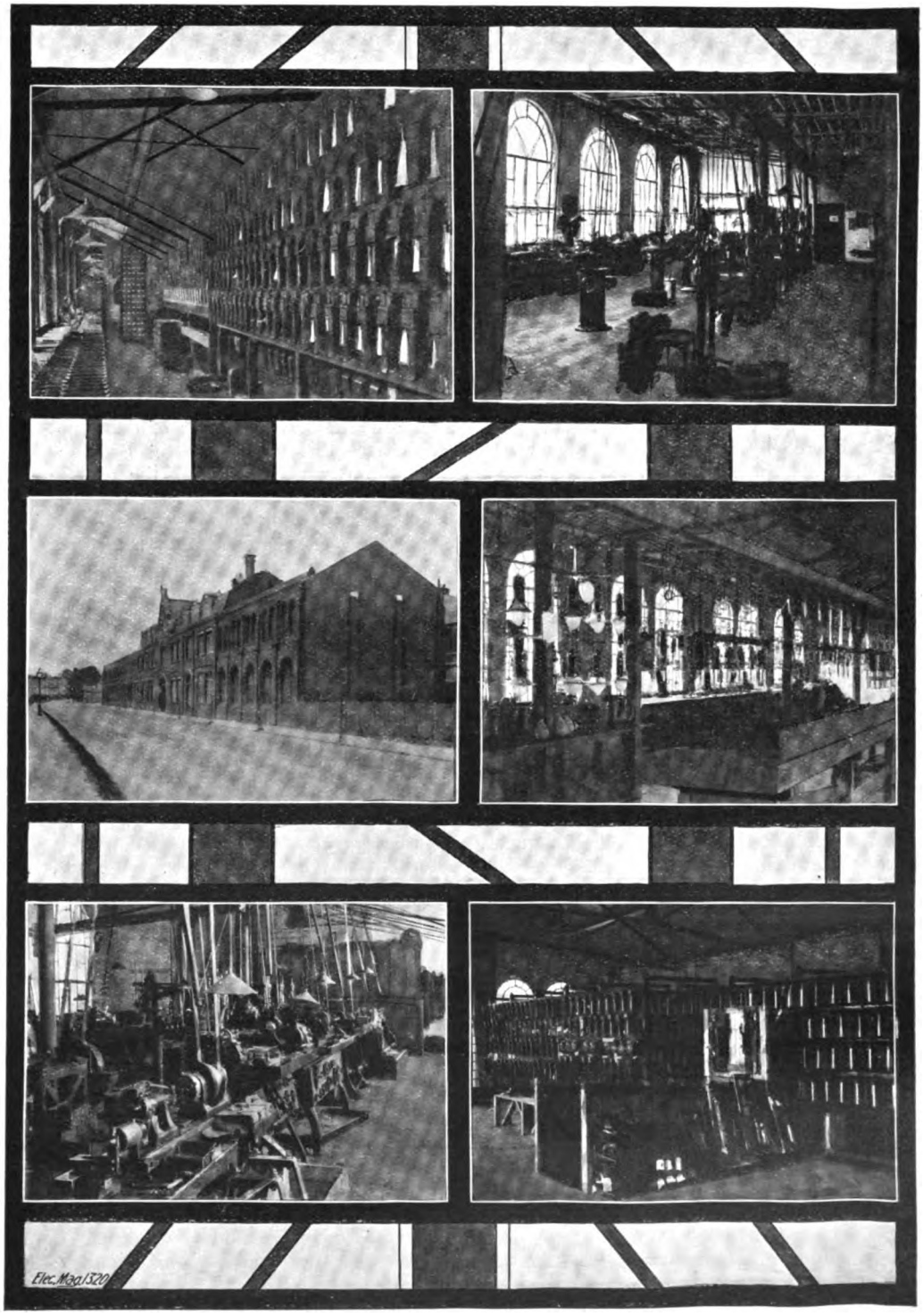
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through, so that special machine tools are not required. The chief metal working appliances comprise lathes and drilling machines, there being also emery wheels and automatic screw-making machines. Some enterprising and over-zealous American might have looked for automatic machines for most of the small repetition work, but there are limits to such methods of production, a fact which has been fully recognised by the management. At first sight it might seem as if general standardisation was feasible or even necessary, but closer examination reveals the whims and fads of consulting engineers, and not infrequently of central station men, which render this desirable state of things impossible. Inability to standardise wholesale, however, does not necessarily impose limits to organisation. At any rate, if it does in some works, it certainly does not in the works of the Reason Manufacturing Co. We were much impressed both with the departmental system and the close attention paid to the many details in its various branches. The works have been divided into a number of departments, each of which is allotted one or more operations, and in the works accounts the results of these are separately recorded. Each department has its distinguishing letter, and each contributes its quota to the total output of the works. Department A is given up to the turning, drilling, and screwing of meter cases, fuse boxes, and small parts of the same. Modern turret lathes are installed for small repetition work, and automatic screw-cutting lathes produce a large proportion of the screws required. Adjoining the same department is a grinding shop for cleaning up cast iron cases, and close to this is a small brass foundry where all the requisite brass and aluminium castings are made. In another part of the works is Department E, devoted to the manufacture of arc lamps. This comprises a machining, a fitting, and a testing department, the former containing several fine lathes and drilling machines. The lamp parts are assembled in the fitting department, and then submitted to exhaustive burning tests. In Department K the glass blowers are situated, and here



THE MANAGING DIRECTOR'S OFFICE.

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The Reason Manufacturing Co.'s Works.

Demand Indicator Test Room.
Exterior of Works.
Machining Department.
Drilling and Turning Department.
Arc Lamp Department.
Electrolytic Meter Test Room.

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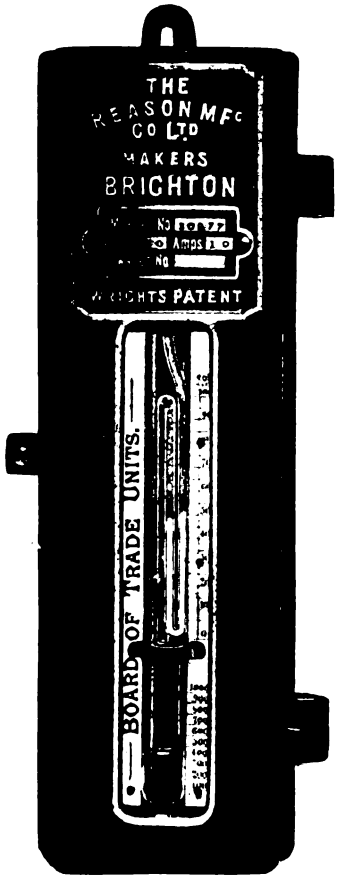
some very interesting processes were to be seen. All users of the famous demand indicator and now equally famous electrolytic meter will be familiar with the fantastic shapes assumed by the glass portion of the respective devices. In the fashioning of these, great dexterity, acquired only by constant practice, is needed, and only to reliable workmen can the work be entrusted. Naturally some thousands of feet of glass tubing are annually used in the formation of the special sizes required for the meters manufactured. A separate department accommodates the electrolytic meter assembling and testing sections. In the latter numerous racks are provided to take meters for calibration and testing. A very interesting portion of the works was that in which demand indicators were tested. This is a long room filled with racks in which up to 1,000 indicators can be placed. Special clips hold the instruments in position and short cable lengths provide means for connection to the testing circuits. Each meter has its own scale prepared, and no two scales are exactly alike. According as the higher or lower readings require to be open or close so is the scale marked out, but even when the requirements are identical the scales differ somewhere. It is frequently said that the scales are machine drawn and the meters adjusted in some mysterious way to compensate for errors, but from personal observation we can vouch for the inaccuracy of any such statement. Below the demand indicator testing room is the prepayment meter and the time switch shop. Here numerous interesting devices are made, assembled, and tested. To these, as also the other manufactures, we shall refer later. A very interesting department is that in which the mercury used in the electrolytic meters is cleaned. Several processes are in use, all of which are necessary to insure the chemical purity of the materials. In other shops such operations as making meter boards, drilling insulation, painting and packing are carried out.

The accommodation of the office staff, which is frequently looked upon as a minor detail, has been carefully dealt with, and as a result commodious quarters have been allotted to them. Parsimony in the commercial department of any works is bound to reflect on the balance sheet, more especially as modern business methods impose a rather more severe strain on the clerical staff; consequently, it is good policy to be as generous as possible in providing for their comfort. From what we saw of the offices at the Reason Works no expense has been spared and neither space nor equipment have been limited. Needless to say, the card system is freely used, and the many advantages it confers are realised to the full. Its extreme flexibility permits of a special system being employed both for the various departments and the works as a whole. It is by the use of modern systems and methods in the office that work can be speedily passed through the shops, as the management can trace the progress of any particular order and ascertain and correct causes of delay. We emphasise this circumstance because it directly interests and affects the customer, who is generally anxious to have delivery of his goods in as short a time as possible. It is only by this organisation at headquarters that economy in manufacture and promptness of despatch can be assured.

ELECTRICITY METERS.

Four distinct types of meters are manufactured, and three at least of these are very widely used. They are the maximum demand indicator, the electrolytic meter, and a motor meter with a prepayment attachment. The demand indicator is too well known to need detailed description. It has been developed from a great number of types, but is now practically standardised for both alternate and direct currents. We are, of course, referring to the thermal form of instrument. Among the special types is one for measuring the maximum demand of a three-wire installation. In this case it is obviously unfair to use two indicators and add their readings. In the special form of instrument the indicator is inserted in the neutral wire. This wire is divided in the instrument, and two equal resistances are inserted in the branch. Across the ends of these the indicator strip is connected. The resistances being very low the total loss is less than with the two-wire arrangement. For heavy alternate-current circuits a current transformer is used and the demand indicator connected to its secondary winding. Both transformer and indicator are mounted on one board, thus making a neat arrangement. The demand indicator is also combined with an electrolytic meter for continuous-current circuits, but to this pattern of instruments we refer later. The manufacture of all these

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WRIGHT'S ELECTROLYTIC METER

demand indicators is undertaken with extreme care, and everything possible is done to ensure accuracy in the completed instrument. Engineers unfamiliar with them are apt to condemn them as flimsy and delicate, but the assembling of the parts, in themselves, light and fragile, has been so well accomplished that, from a mechanical point of view, the instrument is as nearly perfect as brains can make it.

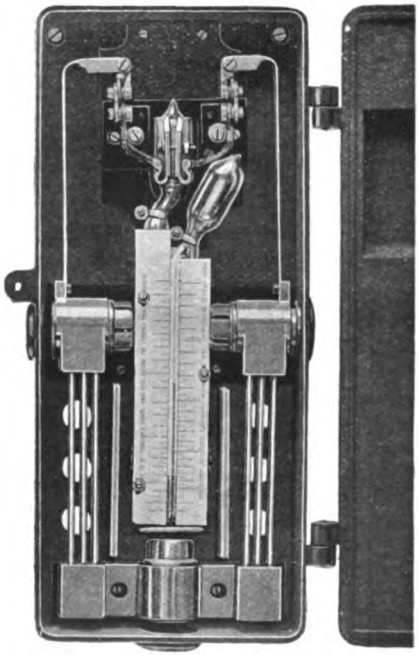
A less expensive instrument of the electromagnetic type has recently been introduced. In this pattern the pull of a small magnet is used to tilt a reservoir containing liquid, thereby causing the latter to overflow into the recording tube. The glass container, with the scale card, is mounted on a pivot, to which are also rigidly attached the plunger and adjustable weight. For all ordinary purposes this pattern of instrument is thoroughly reliable, and quite a large number are constantly on order.

The electrolytic meter has been brought to a stage of commercial perfection after numerous and exhaustive experiments. The principle of the instrument depends on the deposition of mercury from a solution of mercurous salt by the passage of a continuous current. The electrolytic cell is connected with a shunted circuit, and in a meter of 5 amps. capacity about .025 ampere passes through it. The anode consists of metallic mercury and the cathode is of platinum, both these being contained in a hermetically sealed glass tube. The mercury rests in an annular depression in a bulb at the top of the tube, and a special feeder is fitted to the larger types of instrument which keeps the level of the mercury constant. Registration is effected by the dropping of the mercury from the cathode into a graduated syphon tube. After 100 units are measured this tube empties itself by syphoning action into the lower part of the tube, which is provided with a scale, each division of which is 100 units. On the registration of 1,000 units the meter requires resetting. This is done by tilting the tube and causing the deposited mercury to return to the anode chamber. The meter is then ready to register up another 1,000 units. The meter is extremely accurate, chiefly on account of the absence of back E.M.F. in the electrolytic cell. This does not exceed $\frac{1}{10000}$th of a volt, and as the drop in the meter is one volt at full load, the disturbing effect of the back E.M.F. at $\frac{1}{100}$th load is not more than one per cent. In no case does the drop in pressure across the instrument exceed one volt. A feature of the meter is the automatic stirring of the solution. This is effected entirely by gravity, the heavy solution formed at the anode falling while the weaker solution at the cathode rises, the interchange of particles being assisted by the curved surface of the mercury anode. The smaller types of meter have only a plain graduated tube which reads up to 250 units, and when this amount is recorded the meter must be reset. With the larger capacity instruments the syphon arrangement described above is used. The meters are also combined in one case with a maximum demand indicator, the combination being exceedingly neat and compact. A three wire pattern meter is also used, the connection of which is similar to that of the demand indicator for the same class of circuit.

HOUSE SERVICE FUSE BOXES.

The Company has done a real service to electricity supply in reducing the cost of cousumers' fuses. The supply of these was at one time in the hands of the cable contractors, and the abnormally high prices charged increased the cost of a consumer's installation frequently out of all proportion to his demand. The Reason Co., however, changed all this, and it is now possible to

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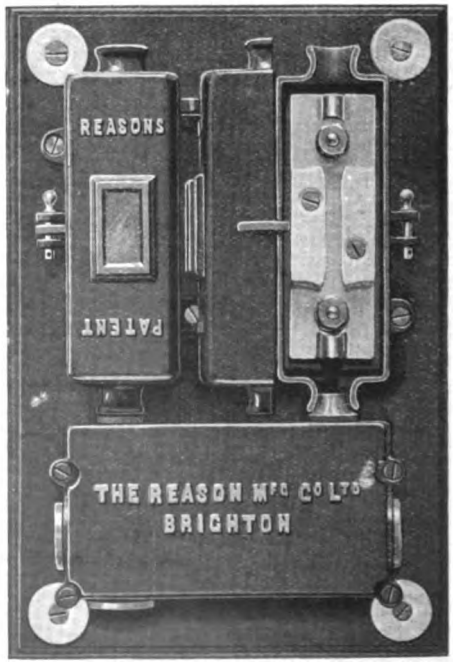
DEMAND INDICATOR, THREE WIRE PATTERN.

obtain at *a fair* market price fuses and fuse boxes for almost every class of cable in use.

The standard pattern fuse is single pole with terminals mounted on a porcelain base, the whole being enclosed in a cast-iron box with hinged lid. All service fuses are now double pole, and for this purpose two boxes are mounted on one board, the hinged covers being arranged to open towards the centre. This is known as the back-to-back arrangement, and is the subject of a patent recently upheld in a litigation case with another manufacturer. It will be seen that the method is very effective in preventing short circuits when the fuses are being examined or replaced, as only one door can be opened at a time. The fuses are made for currents from 5 to 250 amps., and pressure from 100 to 500 volts. The boxes are standardised for single, concentric, twin and three core cable. For cables insulated with rubber, vulcanised bitumen or other non-hygroscopic material, no special leading-in arrangements are made, but when the conductors are covered with paper, jute, or any other substance which will readily absorb water, sealing-in chambers are necessary. These generally take the shape of a cast-iron trough fixed directly below the fuses on the same board. After the cables have been placed in position the trough is filled with compound.

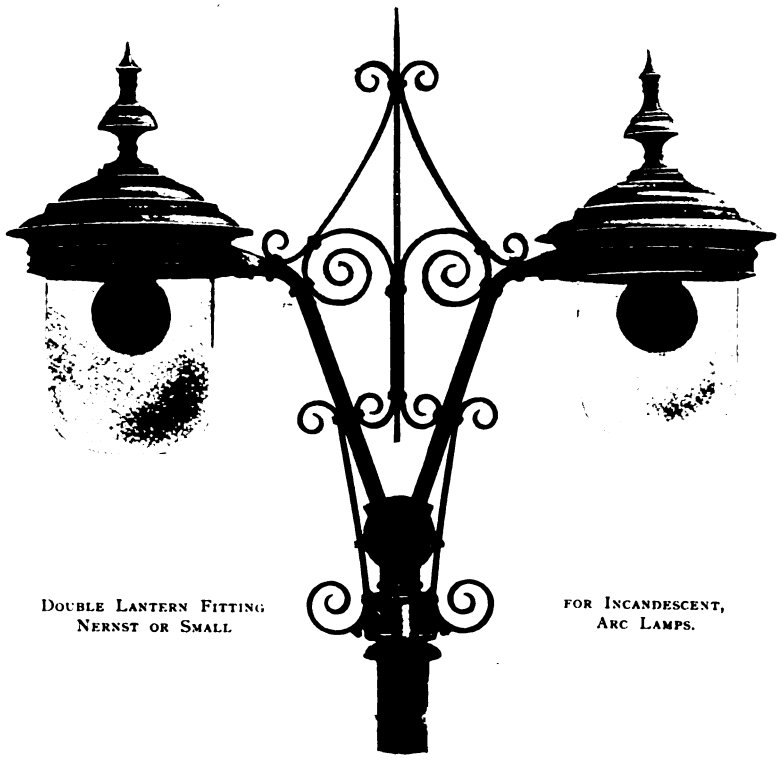
ARC LAMPS.

For several years the company has exploited with considerable success the arc lamp patents of Mr. Frank Lewis. This branch of electric lighting has received more than ordinary attention at the hands of that gentleman, and his researches in this province have been productive of many novel forms of lamps. His transformer governor lamp will doubtless be familiar to all alternate-current station engineers, while some of his later patterns of the enclosed type will also be very widely known. It is with the enclosed arc lamp the most promising results can be obtained and, consequently, every attention has been paid to the production of a nearly perfect form of it. A feature is made of a twin-carbon lamp for direct-current circuits. In this lamp the two arcs burn in series in one globe and are controlled from one coil, there being also no shunt solenoid. A special limiting device has been fitted by which both arcs are maintained at a similar length, and the feeding mechanism of each is simultaneously released. The limiting device comprises a small electromagnet in series with the lamp,



HOUSE SERVICE FUSES. PATENT BACK-TO-BACK ARRANGEMENT.

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DOUBLE LANTERN FITTING FOR INCANDESCENT, NERNST OR SMALL ARC LAMPS.

a keeper being provided from which hangs a slotted link, in the slot of which is a pin projecting from the controlling lever of the lamp. When current is off the keeper and link fall and the controlling mechanism is free to move through the entire limit of its travel. When current is on the keeper draws up the link and limits the travel of the control lever when the pin attached to it reaches the end of the slot. At this moment current is cut off, the lever is released, and the arcs again strike. The process is so quick as to be hardly perceptible, and as feeding only occurs every two hours the slight blink of the lamp will pass unnoticed. The system has been very successfully applied for the series running of enclosed arc and also for miniature lamps. The latter are made to operate two in series of 200 to 250 volts or to work singly on circuits of the same pressure. In the latter case lamps are fitted with twin carbons. The value of such small lamps is materially enhanced when they have no shunt coils, and it is as well to note at this point that many midget lamps of foreign manufacture are fitted with shunt coils, and that no provision is made for a substitutional resistance in case of failure of one of the lamps. There should be a good demand for these small arcs in competition with some of the later patterns of incandescent lamps, as they cost very little to maintain, and they give a light of a good colour. They are also, of course, very much more efficient.

STREET LIGHTING ACCESSORIES.

A very extensive business has been built up in the supply of poles, brackets, lanterns, reflectors, and switches for street lighting purposes. For incandescent lighting a special form of reflector fitting has been used with very good results, the efficiency of the illuminants being increased by about 200 per cent. when the special reflectors are employed. The fittings are suitable for both ordinary incandescent and Nernst lamps.

TIME SWITCHES.

The extending employment of two-rate meters has brought with it the need for a reliable time switch. The company makes several types of these, all of which have been found highly satisfactory in practice. The switches are all of the knife contact pattern, there being no mercury employed. The

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mechanism is controlled by a clock, which can be set to actuate the electromagnet closing the switch at any time. The device is exceedingly compact, and being enclosed in a cast-iron case is thoroughly substantial. One pattern is fitted with a self-winding arrangement by which a small electromagnet is energised and by the movement of its armature revolves the winding spring barrel a few notches.

CONCLUSION.

From the above brief description it will be noticed that the Reason Manufacturing Co., Ltd., is exceptionally well placed to supply electrical apparatus in the shape of meters, fuse boxes, arc lamps, and other accessories of good design and highest quality. The idea seems to have gained prevalence that the manufacture of every class of electrical apparatus can only be successfully undertaken by a large concern subdivided into departments each one of which produces some special article. On the Continent and in the United States are to be seen large works making everything electrical, from a meter to an alternator. It is a matter, however, for some doubt whether these huge factories can pay the same attention to detail in departmental production as can a separate concern which stakes its reputation in one branch of manufacture. The records of the Reason Manufacturing Co. fully bear this out. They have devoted time and money to the perfection of the electrical devices to which we have referred, and the world-wide appreciation of these must afford considerable satisfaction to the management and engineers of the company. We cannot say entire satisfaction, as that would signify a lack of desire for further development. It is evident, however, that no such policy of lassitude will characterise the action of the directors, but that the same vigorous spirit which has brought the company to its present flourishing condition will always predominate and establish an even wider reputation for the electrical products of the undertaking.

A Large Frequency Changer.

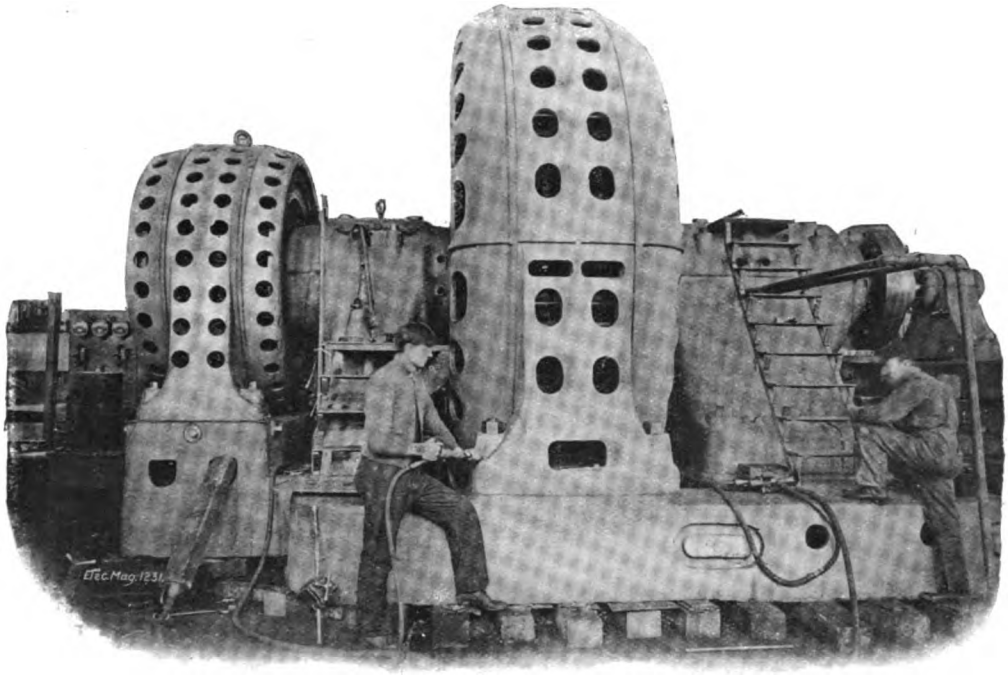
THE 8000 h.p. synchronous motor generator set, illustrated herewith, is undoubtedly a unique piece of apparatus. It consists of a 5750 k.w. alternating current generator, an 8000 h.p. synchronous motor, and a direct connected induction motor for starting purposes. The motor is capable of developing a maximum starting torque equivalent to 2500 h.p. This set is not only the largest frequency changer ever built, but it is composed of the largest alternating current generator in operation at the present time, and the largest electric motor ever built.

The armature yoke of the generator is of cast iron, in halves, held in proper alignment by dowel pins and square splines, and securely bolted together. This casting is so cored as to allow the entrance of an abundance of air for ventilation. Throughout the steel core brass castings are spaced at frequent intervals, which provide for ample ventilation. The coils are firmly held by a wooden coil support, bolted to the stator yoke shields on each side, thus rigidly holding them in place. The total weight of the stator is 80,708 lbs.

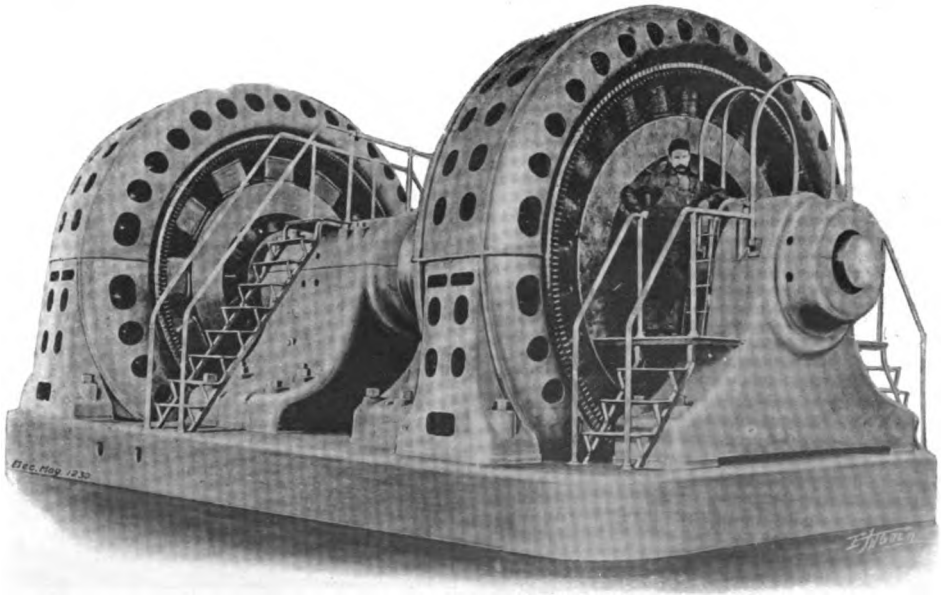
The rotor poles, of which there are twenty-four, are also built up of soft sheet steel, held together by phosphor-bronze end plates, securely riveted. Each pole weighs 1130 lbs., and the complete rotor weighs 78,455 lbs. The mechanical construction of the synchronous motor is quite similar to that of the generator, there being, however, only twelve poles, each weighing 2200 lbs. The complete stator weighs 93,250 lbs., and the rotor complete weighs 80,595 lbs.

The set was tested under full load conditions in the shops of the Bullock Company by the method suggested by Mr. B. A. Behrend, chief engineer of the Company. In testing the generator, having twenty-four poles, the machine was connected so that twelve poles were in opposition to the other twelve poles. Half of these coils would then be acting as a generator and the other half as a motor. The armature current would tend to magnetise the poles of the motor half, and demagnetise the poles of the generator half, which would subject the machine to violent vibrations. In order to obtain magnetic balance, each half is excited differently by placing a rheostat in series with each section, and regulating the current. The C.2R loss is also accurately obtained in this manner, as full load current is made to circulate through the armature coils, and also full load current is carried by half the number of poles.

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ALTERNATOR AND INDUCTION MOTOR ON TEST PLATE.



8,000 H. P. FREQUENCY CHANGER COMPLETE.

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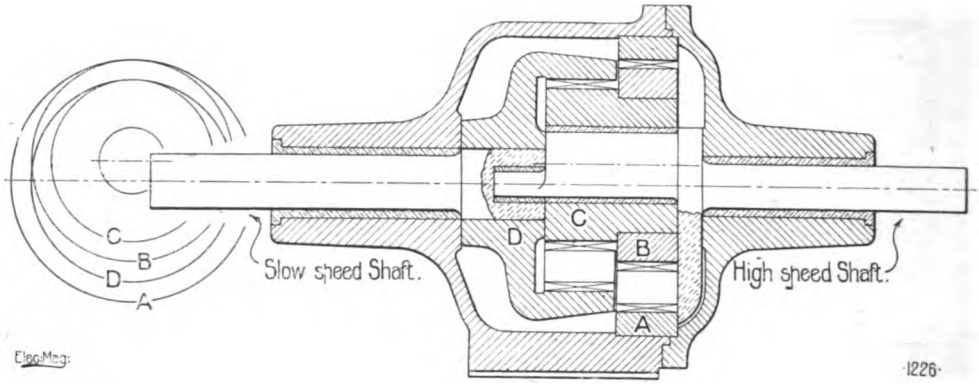


FIG. 1. SECTION THROUGH GEARS.

Speed Reducing Gears.

A NEW form of speed reducing gear has recently been introduced by Messrs. R. G. Ross and Son, Greenhead Engine Works Glasgow. From particulars furnished by the firm we understand that these gears are much used for driving pumps, hoists and winches, and are giving every satisfaction. They are especially valuable for electric winches, as they can be used for transmitting the power at a reasonable speed. Fig. 1 is a section through a small set of gear. The high-speed shaft has a crank and a corresponding counter-balance. Inside the casing is a fixed wheel A, gearing with wheel B, which in conjunction with wheel C works free on the crank. The internal wheel D is keyed on the low-speed shaft. When the high-speed shaft is set in motion the wheel A, being fixed, retards the motion of B, and thus the reduction is effected. In the case of winches and hauling gears for colliery work the gear is placed inside the barrel, and by this means a very strong and simple arrangement is made, and one which is moreover free from danger. We understand that the gears are in use for driving Jukes' furnaces from an electro motor. In this case the motor runs at 460 revs. *per minute*, and the tail shaft revolves at 4½ revs. *per hour*. That is a ratio of reduction of 6,133 to 1. The gears are positive in action and the wheels work in oil. All the gear is on the one centre line, and the teeth of the driving wheels being internal and external, a greater number of teeth are always in mesh, thus making the whole arrangement extremely strong and reliable. Variable speed gears are also made on a similar plan for motor cars. In Fig. 2 we give an illustration of a number of electro motors fitted with the gears.

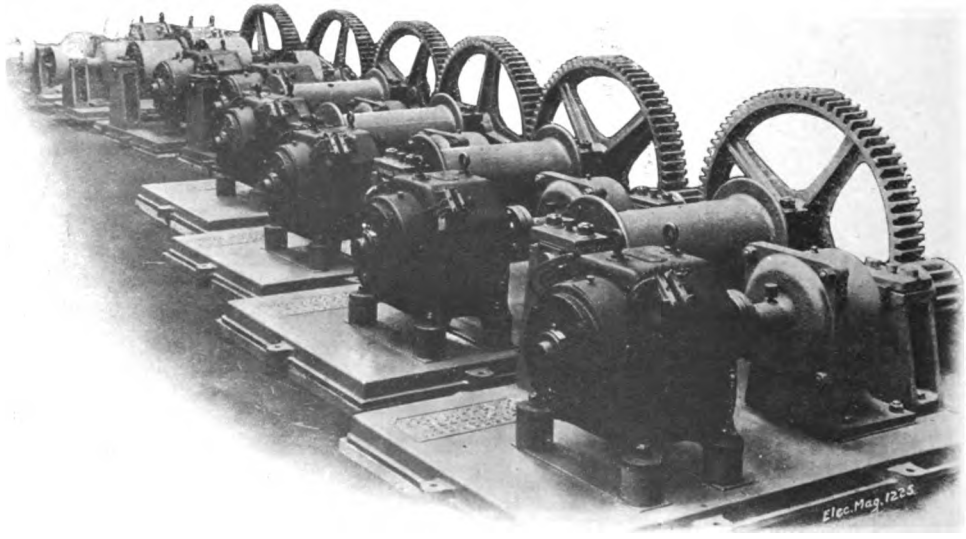
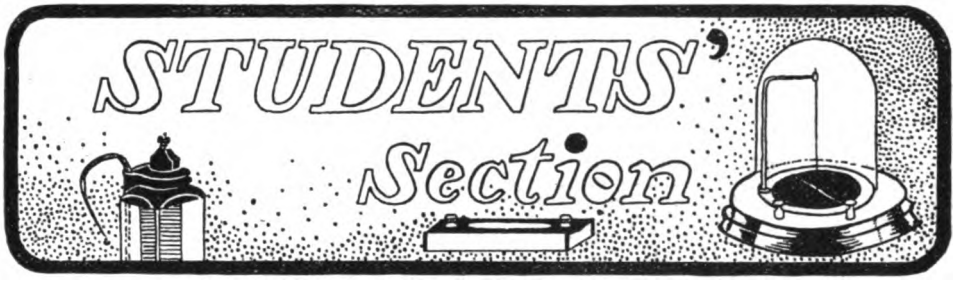


FIG. 2. GROUP OF MOTORS FITTED WITH ROSS REDUCING GEARS.

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Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

Problems on Distributing Networks.—VI.

By ALFRED HAY, D.Sc., M.I.E.E.

(*Continued from p.* 393.)



We may now explain the application of the principle of superposition to a method—originally devised by Coltri—of determining the current distribution in a complicated network of mains.

The method consists essentially in replacing the actual current distribution by two imaginary ones, of which the first is such that, with the actually existing load currents, *each node* of the network is made a *feeding-point;* while the other is one in which, using the existing feeding-points, we load the network with currents *at the nodes only*, the value of these nodal load currents being numerically equal to the supply currents fed into the network in the first imaginary current distribution. The two imaginary distributions when superposed obviously give the actual distribution.

The general problem thus resolves itself into two simpler ones, viz.:—(1) the determination of the current distribution in a network of which every node is a feeding-point; and (2) the determination of the current distribution in a network loaded at the nodes only.

The solution of (1) is extremely simple, for if each node is a feeding point, then the entire system breaks up into simple (*i.e.*, unbranched) lengths of distributor fed from both ends—a case which we have already considered in detail (pp. 219 and 309 of this volume).

The solution of (2) is much more difficult. In establishing the equations, it is convenient to choose the drops from the feeding points to the various nodes of the distributing system as the unknown quantities. A system of linear equations is then established each of which expresses the fact that the algebraical sum of the currents flowing towards a node is equal to zero (Kirchhoff's First Law). There will be as many equations as there are nodes, *i.e.*, as there are unknown quantities to be determined. The next step is the solution of the system of equations. This is an extremely laborious process if the ordinary method of successive elimination be used, or if the solution is expressed in determinantal form. The work is greatly simplified by the adoption of a method of successive approximations due to Seydel, which possesses the further very great advantage of enabling the results to be checked at any stage of the process of solution.

The reader will best be able to understand the method by a careful study of the following somewhat complicated numerical example, shown in Fig. 20. A network, consisting of four meshes and two unbranched distributors, F_1A and F_2E, is fed at the points F_1 and F_2. The distribution of the load currents is indicated by the lines with arrow-heads, and the figures attached to the various members of the network give their

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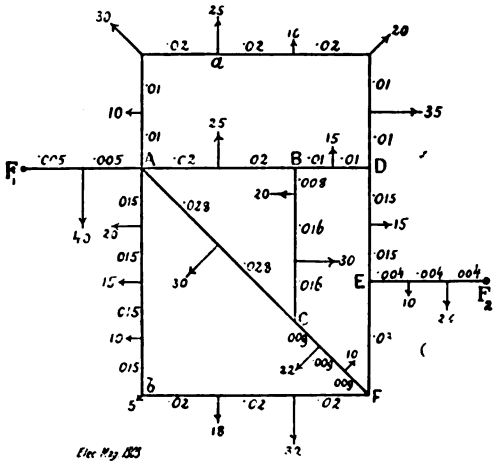


FIG. 20.

resistances (the resistances refer to the *double* main). The problem is to find the currents in the various distributors, the points of lowest potential, and the drops from the feeding-points to the points of lowest potential.

As already explained, we substitute for the actual current distribution two imaginary ones. The first of these is one in which we have the actual load currents, but in which the network, instead of being fed at the two points F_1 and F_2 only, is, in addition, fed at each node. Thus we have to regard A, B, C, D, E and F as feeding-points. The entire network is thus broken up into simple distributors, each of which is fed at both ends. We may conveniently use the method of moments to determine the current distribution in this simple case.

Consider first the distributors which radiate from the point A, *i.e.*, AF_1, AB, AC, A*a*D and A*b*F. For the sake of clearness these distributors are separately shown in Fig. 21. In the case of AF_1, AB, and AC no calculation is necessary, as it is immediately obvious that each feeding-point supplies one-half of the total load current. The currents in the various sections are indicated in the diagram in each case. It is now evident that if all the nodes are feeding-points (as well as F_1 and F_2), then the total current supplied to the feeding-point A must equal the sum of the various currents which branch off from A along the distributors meeting at that point. That is to say, the total current fed into the network at A is (Fig. 21):

$20 + 12.5 + 15 + 59.5 + 48.83 = 155.83$ amps.

We next consider the three distributors radiating from the node B. Proceeding as before, we find for the total current fed into the network at B:

$12.5 + 28 + 7.5 = 48$ amperes.

Similarly, we find for current fed into network at:

C = 15 + 22 + 18 = 55 amperes
D = 70.5 + 7.5 + 7.5 = 85.5 ,,
E = 13.33 + 7.5 = 20.83 ,,
F = 51.17 + 14 = 65.17 ,,

The complete distribution of currents when the nodes are made feeding-points is shown in Fig. 22.

On this distribution we now have to superpose another, in which the only feeding-points are the actual feeding-points F_1 and F_2, and in which the only load currents are currents at the nodes, equal in magnitude to the currents fed into the network in the first distribution. There will thus, in this second imaginary distribution, be altogether six load currents, of amounts 155.83, 48, 55, 85.5, 20.83, and 65.17, taken off at the points A, B, C, D, E and F respectively. We shall find it convenient to determine the *conductances* (*i.e.*, the reciprocals of the resistances) of the various distributors which act as connecting links between the nodes of the network; since in that case in obtaining expressions for the currents, the quotients $\frac{\text{P.D.}}{\text{resistance}}$ will be replaced by the products P.D. × conductance, and the equations will appear cleared of fractions. The resistances and conductances of the distributors forming the network are given in

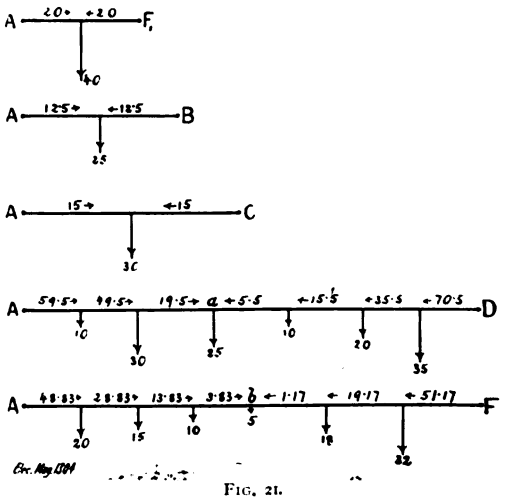


FIG. 21.

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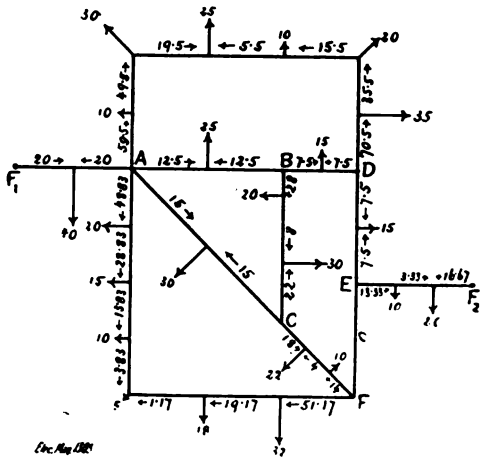


FIG. 22.

tabular form below. (Compare the values with Fig. 20, from which they have been obtained.)

Distributor.	Resistance.	Conductance.
AF_1	.005+.005=.01	100
AB	.02+.02=.04	25
AC	.028+.028=.056	17.86
AD	.01+.01+.02+.02+.02+.01+.01=.10	10
AF	.015+.015+.015+.015+.02+.02+.02=.12	8.33
BC	.003+.016+.016=.04	25
BD	.01+.01=.02	50
CF	.009+.009+.009=.027	37
DE	.015+.015=.030	33.3
EF_2	.004+.004+.004=.012	83.3
EF	.03	33 3

The Apprentice's Standpoint.*

AT a recent annual banquet—the fourth of its kind—of the apprentices of the American Westinghouse Co., Mr. D. O. Hales (New Zealand) made the following remarks, which we commend specially to the notice of our junior readers:

"After coming to this country I entered the apprenticeship course of a large company which was not only going to give me fifteen hunderd dollars' worth of instruction, but was going to pay me while receiving this experience. I found a special department under the official charge of a foreman working as a part of the great system. I was to be sent from department to department, I was to be placed alongside skilled workmen, I was to observe their work, to question them about it, to do the work myself.

"I had not been long on the course before I found that there was now and then dissatisfaction felt by some of the apprentices: 'Things don't go to suit us, the foremen are not appreciative of our talents. We want to go on test and no notice is taken of our complaints; we are treated just as if we were machines.'

"Where did the fault lie? Was it with the system, or was it with the men?

"'The foremen are inappreciative.' Perhaps at first! They perhaps have had too many disgruntled men loafing under them to hail a newcomer as anything out of the ordinary, and it usually takes some time to establish an understanding. But it was always my experience that when the foreman came to know his men, they were fairly treated.

"'The departments are wrong.' Everyone could not be in the busy or attractive sections at one time, and if you happened to be in a slack section, there were not serious objections raised to your going over to another department at odd times to see what you could learn by observation; provided always that you did not hinder men who were at work or turn your visit into a social call on an old college chum. It was annoying on test to ask a fellow apprentice to go behind the board and plug in the rack for you, and then, on receiving no answer to your signals, to find him with his back towards you enjoying a chat with two or three old college mates.

"Everyone has his own idea of what things are most beneficial to him. On a recent visit to my old school I was asked what were the most important points to be found in connection with our apprentice course. I answered, 'First, I have had the chance of being a unit in a great organisation, and of observing some of the details of that organisation. Second, I have come into personal contact with men who have distinguished themselves in engineering and scientific work. And third, I have worked with the working man as a working man.'

"The advantages accruing from the first two will be evident to all, and it is of the third I wish to speak when I refer to the future of the apprentice. By future I do not mean the days immediately following the close of your apprenticeship course, when your talents have won worthy recognition, but to the days when you have taken a place in the world either as engineers in some organisation or as business or public men.

"In a country such as this, where your national games are played by men at college or by professional athletes, and where the spirit of commercialism has so crept into your sports that a ten-year-old youngster

* *From the Electric Club Journal.*

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signs on to his baseball team and will hardly travel three blocks to play a game unless some one guarantees his expenses, you do not have the advantages of seeing the working man at his best and worst that we have in our more favoured land. There Saturday after Saturday during the summer, the merchant, the manufacturer, or the banker can be found playing cricket with or against his clerks or mechanics; and during the winter the engineer, the lawyer, the mechanic, the butcher, the baker, and the policeman may be all mixed up in the friendly tussle of a football match. But your work during your apprentice course gives you a great opportunity for studying the working man.

"You may become managers of great businesses, you may have the handling of scores of men, but you will never have the same opportunity to acquire sympathy for labour as when you work with the working man as a working man; and when I say working man I do not take the broad academic meaning of the term, but the narrow view, the working man as a man who does manual labour for hire.

"You, as future managers of labour, must study the question, not only by personal observation, but by learning what is being done in other lands, in Germany, in England, in Australia—where the labour party controls the senate and holds the balance of power in the House of Representatives—and in my country (New Zealand), where the labour party has recognised that setting class against class is not for the good of the community, and by their votes have kept in power a ministry composed of men, not labouring men, but who nevertheless have been able to much for the cause of labour.

"In this country the labour unions are frowned on by the capitalists and manufacturers. Unions have usually brought industrial warfare and industrial depression.

"As time goes on the factory hours must become as short as what are now known as office hours, and when that time comes, you, as managers of labour, must find some better way for your working men to spend their hours of recreation than by loafing around a filthy town where the sole attractions are saloons. You must find some more chivalrous way of treating your female work-hands than turning them out to fight for trolley-car seats against a crowd of hungry men eager to get home. These things may appear to be outside the interest of the manager or employer of labour; but you have only to go over to Allegheny and see the work being done by the Heinz Company, or to remember our own Electric Club and Casino classes to find that some employers do not consider an interest in the leisure hours of their employees to be wasteful and unproductive.

"Gentlemen! In your apprentice course you can learn more than practical engineering. You are under a great leader; you can catch some of the spirit of that leader. You can build up your life character or fame in your profession that your influence will be so felt by your fellow men that when your final account is settled, your family may take pride in the knowledge that they, your neighbours, your community, even your country, are the better for your having lived and worked in their midst."

From Professor to Student.

KELVIN'S TESTING SET.

We should advise you to follow the simple methods and formulæ given in the book of instructions for using Lord Kelvin's Testing Set in making the various tests mentioned. It, however, should be remembered that insulation tests should *not* be made with batteries giving low voltages; the testing pressure should not be less than the normal working voltage, but preferably twice the working pressure. Should one portion of the insulation be inferior to the remaining portion this is detected by using the higher pressures, and although a formula might be deduced giving the insulation resistance per mile for a given applied pressure, such a formula would be useless for giving the insulation resistance per mile independent of the voltage.

In the test for localising a leak to earth, the instructions given under the heading, Method VIII., are sufficient for ordinary purposes. If a loop be used by using a cable of different size, all that is necessary is to calculate the length of cable with the same area of cross-section as the cable under test, which has the same resistance as the portion added to complete the loop, and to add this length to the length of the cable under test. It is particularly important to see that the insulation of the additional cable is satisfactory.

ARMATURE DIMENSIONS.

The following notes respecting the dimensions and number of teeth of a slotted armature will, it is hoped, assist you in completing your design of a 12 b.h.p. motor armature, but a good deal depends upon practical experience, as no hard and fast rule can be given respecting the dimensions of the teeth and slots. Some information as regards the size of armatures was given on page 70, Vol. II., of *The Electrical Magazine*, and, as regards the length of the air-gap, it is obvious that a short air-gap means diminished reluctance, and therefore economy, inasmuch as a long air-gap necessitates more excita-

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tion of the field-magnets. A more important point, however, is the fact that a long air-gap diminishes the distorting tendency of the reacting ampere-turns of the armature, and thus promotes more perfect commutation. As Professor S. P. Thompson, D.Sc., states: "The ampere-turns that have to be provided by the field-magnet coils to drive the flux across the air-gap are proportional to the length of the gap, and if they are relatively large commutation is better. In this respect the ampere-turns on the magnet core which have to be provided to drive the flux through the highly-saturated teeth are also helpful. Hence it is found that for highly satisfactory working the ampere-turns for gap and teeth (*i.e.*, that part of the excitation provided for these) must bear a certain proportion to the number of ampere-conductors of the armature per pole." As an approximation, the ampere-turns required for the teeth may be taken as 25 per cent. of those required for the air-gap.

The permissible flux-densities for the air-gap and teeth are generally fixed, and if we denote these quantities by B_g and B_t respectively, then the width of the teeth take up $\frac{B_g}{B_t}$ part of the periphery of the armature core. If anything, the width of the teeth is narrower than the width of the slots, and 0.8 might be taken as an average value in your case.

In modern practice the size of the slot is obtained by consideration of the *space-factor*, which is defined as the ratio of the net cross-sectional area of the copper in the slot to the gross-sectional area of the slot, and for motors of the capacity mentioned the space-factor is from 0.325 to 0.35. This brings into consideration the question of insulation, which is a most important matter. It may also be useful to note that the ratio of width of slot to the depth will be about 0.35 to 0.4.

TESTING SET.

A subscriber (New Zealand) states that upon taking an insulation test (by means of Evershed's ohmmeter) to earth of the two mains AB and CD of a two-wire lighting circuit, the following values were obtained:

Insulation of AB to earth .. 55,000 ohms.
" CD " 45,000 "

The ends B and D were then connected together, and also connected to the ohmmeter (the other ends being free) and the insulation resistance to eartn of the pair of mains taken; the value 35,000 ohms was obtained. Since all leakage paths to earth are in parallel, it was expected that the last result (25,000 ohms) would be the joint resistance of 55,000 and 45,000 ohms, but this is, by calculation,

$$\frac{55{,}000 \times 45{,}000}{55{,}000 + 45{,}000} = 24{,}750 \text{ ohms.}$$

Naturally, the accuracy of the ohmmeter is doubted. Our subscriber, however, should remember that the distribution of the leakage paths will in all probability be different when the two mains are joined together, as indicated above, to what it is when each main is tested separately, and the results obtained may be absolutely correct according to the conditions of the test. If the two mains be connected in series so as to make one line—not side by side—it will probably be found that the joint resistance will be found to agree with the individual values. If the conductance method of making the calculation for resistance connected on parallel be adopted it should be noted that

$$\frac{1}{R} = \frac{1}{55{,}000} + \frac{1}{45{,}000},$$
$$= .00001818 + .00002222;$$
$$\therefore \frac{1}{R} = .00004040,$$

and $R = 24752$ ohms,
and not 33.333 ohms, as our subscriber states.

In reading through the "Students' Section" for February I came across a misprint in the table at the bottom of the second column of p. 220. In the calculation of stage 6 for the feeding-point F_2, the addition of 2360 and 2475 is given as 4535 instead of 4835.

We are much obliged to our correspondent for pointing out the above error. The second equation on p. 221 should read

$$1600 + 120x = 4835 + 180y,$$

and on solving the two equations for x and y, we find $x = 28.78$, $y = 1.22$, instead of $x = 27.78$ and $y = 2.22$ as given The total drop along the double main is 1.96 volt instead of 1.914 volt, and in Fig. 12 the distribution of currents shown will be slightly modified in accordance with this correction.

Would you be so good as to advise me, through your "From Professor to Student" column, as to a book on trigonometry, and books on direct and alternating current machinery? It is impossible for me to attend lectures, as I am engaged in the erection of large plants. I can manage any practical work, but I want to study and gain a theoretical knowledge of electrical engineering.

As regards trigonometry, we should advise our correspondent to try Lock's "Trigonometry for Beginners," published by Messrs. Macmillan & Co., at the price of 2s. 6d. With regard to electrical engineering text-books, if our correspondent wishes to get a comprehensive yet simple treatise on all branches of the subject, we should recommend "Modern Electric Practice," edited by Prof. Magnus Maclean, and published by the Gresham Publishing Co. This work is in six volumes (the last volume has not yet appeared), at 9s. per vol. But if his studies have not extended very far, we should recommend him to begin with Prof. Ayrton's "Practical Electricity" (Cassell & Co., price 7s. 6d).

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The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. Consult it and save yourself much valuable time.

Are Lead-covered Cables Doomed ?

By J. H. C. BROOKING, A.M.I.E.E.



THAT type of cable which is insulated with paper or jute and sheathed with lead has been the cause of considerable trouble at various times through electrolysis, which troubles may not always have been made so publicly prominent as in connection with the recent Bradford wholesale breakdown. This, by reason of its far-reaching effects on the trade and convenience of that town, has seized upon the electrical imagination and has led to the above question being commonly asked.

In answer: there is no doubt but that those lead-covered cables now in operation which are laid in connection with a mongrel system of bonding, and earthed as fancy directs, will in due course become food for newspaper paragraphists; especially where there is an electric tramway service also in operation. On the other hand, where lead-covered cables are properly bonded across all joints, effectively earthed at the point or points, nearest (as regards conductivity) to the generating station, and subjected to regular insulation tests, there is little or no chance of danger. This is the ideal system for use with lead-covered cables, but, as ideals in real life are to be met with at about the periodicity of angels' visits, it behoves us to consider what is the best system of cables to use for the various classes of mains now in operation, where the very human elements of ignorance and carelessness have to be taken into account.

For high-tension mains, and particularly those working at extra high tension, the prevailing practice is to use paper-insulated and lead-covered cables, to which covering is added either a sheathing of copper tape immediately under the lead, or an armouring of galvanised iron wires immediately over it. These further processes are to insure that any stray current getting on the outside of a cable will be afforded ample conductivity to enable it to travel back to the generating station without appreciably shunting, for instance, through the body of a person in contact with it, or destructively departing from the lead to get back per waterpipe express. The external iron wire armouring is further useful as a mechanical protection. For high pressures either paper or rubber must be used as the insulator; and with paper the general thing is to lead-cover it. Rubber has been used for extra high tensions in America but it has not been persevered with, possibly on account of the extra cost. So that with this lead-covered class of main it is most necessary that more than the usual precautions are taken, to insure that ordinarily good results are achieved, and as a rule such precautions have always been observed in the laying, jointing and maintenance

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of such cables. For one thing, this E.H.T. class of cable has only been brought into use comparatively recently, so that the lack of experience which has caused such trouble with older established mains of lower tensions may not apply hereto.

In connection with the earlier E.H.T. cables laid in large cities some of the precautions taken were most elaborate, and justly so on account of the amount of electric tramway traffic that was to be expected later. Not only were these lead-sheathed cables further armoured, but they were laid in cast-iron troughs, to which they were strongly clamped at each section of trough, and each trough was bolted to its neighbours. This is about the acme of such practice; and recently-laid mains of this class are now generally more simply laid in either wood or stoneware troughs, or are drawn into ducts of the ordinary types. Such sound precautions are taken, however, as to the joints being of equal conductivity to the rest of the cable, and as to the right and proper points for earthing the sheathings, that there should be little fear of this type of main coming to any harm under, at least, present day conditions. Further, as paper is the best class of insulating material at the price for the higher tensions, it is really a case of Hobson's choice.

The various methods of joint bonding in use for E.H.T. mains at present may be of interest to note. The most usual for solid jointing is the lead sleeve, which from its necessarily large diameter is tapered down and wiped on to the cable at both sides of the joint. The additional conducting tapes or wires used with the lead sheath are bound together and sweated. To insure the joint being as watertight as that made by a sober plumber, the whole arrangement is usually put into a box and filled in solid with bitumen all around the sleeve. Where disconnecting boxes are used, say every half mile, the lead sheathing on each side of the joint is connected by insulated cables running through the box, and the copper tapes or iron wires have additional conducting arrangements to insure electrical continuity. Other forms of bonding are used with cast-iron joints, such as brass sleeves screwed into the glands of the boxes and plumbed on to the lead of the cable. Also an arrangement is used whereby the lead of the cable is bound and sweated to a connector which is screwed to lugs cast on each end of blocks.

So much for transmission, and it will be seen that the risks which the lead-covered cable is heir to must be met and overcome by judgment and by care. Now, as to the distributing network: where lead-covered cables are in use there are three systems of bonding and earthing. One is the Whole-Hog-Lead-Bonded System, where every joint is adequately connected across, and where earthed connections are put down at such points that stray current may be got rid of, rather than its junction with the cable facilitated. (And in this matter there appears to be a crying need for the use of discriminating cut-outs upon cable earth connections, so that such currents as may accidently get on to the cable can climb off at convenient spots, but the cut-out would require to operate against an incoming flow, through that particular connection.)

The second system is the Whole-Hog-Insulated-Lead System, where methodical means are taken to prevent a flow of current upon the lead, by insulating it from the joint boxes with ebonite bushes, and at risky situations by cutting the lead away for the space of a foot or so and making up the gap with insulating tapes and compound.

The third "system" consists of the Happy-Go-Lucky Arrangements which lie between the two opposites just described. Some of these were started with elaborately protected systems of bonding, &c., and continued thus while in care of the original engineer or mains superintendent who laid down the system. With changes, however, came alterations and omissions, or it may have been merely due to a jointer's caprice in omitting to bond service joints across or to replace bonds disturbed for testing purposes. Or it may have been that the bonds originally put in were so meagre in section that the first big rush of current which took place melted them away in detail. There are so many ways of interrupting a system of L.T. cable bonding (which, alas! is not usually looked after with the same care as is bestowed upon an E.H.T. system)

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that it almost seems preferable to start operations upon System No. 2 just described, on the Mohammedan principle that negative virtues are easiest to maintain. The fate of lead-covered cables, therefore, largely depends upon the system of bonding in use. With either Nos. 1 or 2 properly carried out matters should be fairly safe, but the half-and-half method of No. 3 is an example of the occasional futility of the Middle Course. Where there is a possibility of this unfortunate course being followed, the best plan would be to put in vulcanised bitumen cables, preferably laid solid. There is no doubt that the solid system, like charity, covers a multitude of sins, in helping to maintain cables which may not always be quite up to the requirements of more trying situations. It is a pity that it is impossible to use this system for all classes of networks, and this may be on account of the scarcity of latter-day prophet-specialists, gifted in foretelling the exact copper sections needed for electricity supply districts. Vulcanised bitumen cables, once peculiar to the Callender Company, are now being successfully made by other English firms of cable manufacturers, who evidently anticipate that electrolytic troubles upon lead-sheathed cables will increase the demand for a non-metallic covering.

The principal objection to the vulcanised bitumen class of cable is the possibility of the conductor decentralising; and, given an undue amount of heat either externally (such as when passing the now historical baker's oven) or internally, through heavy currents flowing, there is the chance of this happening. This contingency can, however, be guarded against by enveloping the conductor with a thickness of Manilla paper, which will also add to the insulation resistance by its superior efficiency as a dielectric, and will prevent the wires from sinking into the softer bitumen compound.

The beauty of a system of bitumen cables is not so much that it refuses to carry upon its exterior surface tramway and other foreign currents, but that any fault which may happen upon it is quite local in effect. With lead-covered cables it is otherwise. For example: leakage current from a blow-out upon a lead-covered cable laid solid may travel hundreds of yards before it finds a spot that will conduct it to earth, but having found it, there it will work as much destruction, in arcing to its Mecca, as it originally caused at the initial point of trouble. Further, if on account of free-and-easy testing arrangements which are still somewhat in vogue, the leakage is allowed to go on, the escaping current, after eating away all the lead within sparking distance at the first earthing point, will find another and yet another place to attack, until possibly the conductor is burnt in half at the first fault by the neglected leak. The place is then duly discovered by the disgusted authorities, a new piece of cable is let in, and all seems well. In course of time, however, the various offspring from the parent leak begin to assert themselves in a similarly obnoxious way, the interval depending upon the degree of accessibility of moisture to the afflicted parts.

There is little doubt but that the conditions under which lead-covered cables have been worked were not always the most suitable, and that the bad name which they have achieved in some sorely tried quarters has been due to other causes than inherent defectiveness. In the old days, say seven or eight years ago, it was a very good custom to serve such cables overall with a double layer of jute or hemp, and the additional mechanical protection was produced at a very slight extra cost. This was a very wise form of insurance, and was of good service when used for drawing in, or even when the cables were laid solid. The latter process is very frequently more trying to the fragility of a cable than is the operation of drawing in, as when the cable trough is run under householders' service pipes, or has to be bent around street posts, projecting cellars or other obstructions, there is considerable amount of chafing and strain put upon the cable when being pulled along the trough, which needs a foreman at every point of danger to efficiently guard against damage to an unprotected cable. Then, where more than one cable is to be put into a trough, the chance of a navvy's ironshod boots indenting the lead is more than a remote possibility, during his peregrinations up and down and in and out of the trench, during the operations of hauling the

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additional cables along, and also when flaking them off the drums outside the trench. In recent years, however, this precaution in covering the lead has very frequently been omitted, and the consequences of this omission may be more serious than is generally understood.

Another cause of trouble upon some types of lead-covered cable is the increased efficiency of the insulating paper as a waterproof covering, and it is singular that this virtue should be the cause of a cable's downfall, through the action of water itself. This is to be explained by the old-fashioned conditions of testing which are still existant in cable factories. In ye olden times the standard method of twenty-four hours immersion in water was useful and necessary before applying the usual instrument tests, as if there happened to be a pinhole or crack in the lead sheathing a single day's bathing was quite enough to make the "spot" fly off the scale and to thereby damn the cable under test. The breakdown test, afterwards, would locate the defective point exactly, by blowing it out with a bang. Nowadays, however, with the best cablemakers the paper is so well treated with the mystic compounds used that a pinhole or two does not admit enough water during twenty-four hours' immersion to appreciably lower the insulation reading, especially as damp ends, or other contingencies in manufacture, have to be allowed for in connection with such tests. Consequently, it may happen that a cable, slightly defective as to its sheathing, is passed by the test department and sent out, to be perhaps drawn into a wet duct or laid in a reeking subway. Then, as time goes on, the insulation gradually gets soaked with local moisture, until at last a burn-out occurs and—the mains superintendent gets another black mark in the Recording Angel's book. Or, there may even have been only enough moisture sucked into the outer layers of the paper from the tank to pass the insulation and pressure tests, and yet to be able disastrously to soak through to the conductor after the cable has been laid solid.

There are two ways of remedying this state of affairs: one is to *lengthen the period of immersion* before testing to quite forty-eight hours; and the other is to *apply the water under pressure* to the cables. The former arrangement would be a serious thing for cablemakers, with their already overworked tank arrangements, as it would mean doubling the capacities of their tanks. Also, it would further delay the dispatch of cable to customers, and cablemaking processes are quite lengthy enough without adding to them. So, while it is unlikely that this method will come into general operation, there is a great deal to be said for the hydraulic tests also mentioned. This is now made use of by the firm of Glover and Co., who find the process of value in discovering even microscopic defects in lead-sheathing operations, which under the ordinary tests might possibly be passed as perfect. It further helps to get cable delivered more quickly, as the time necessary for the hydraulic pressure test is only ten minutes or so, that being found amply sufficient for the requirements. A pressure of 100 lb. to the square inch is ordinarily used, but 200 lb. can be put on for special cases when required. If this method were generally adopted the status of the lead-covered cable would be increased, on account of the less chance of danger from minute defects in manufacture.

Reference may be made to another rival of the lead-covered variety: rubber-covered cables, as possessing all the best qualities for laying solid, and (properly made) for drawing in purposes. Rubber is an ideal insulation, but unfortunately the cost is almost double that of paper-lead-covered or of bitumen cables, and further, public confidence in its use for exposed situations has been shaken by bad results at certain towns where it is in operation. The writer's opinion is, however, in favour of this class of cable for many purposes, and as an instance of its unassuming usefulness it may be mentioned that in a certain evil-smelling London district, where rubber cables were laid nearly ten years ago, these cables have been largely used as "feelers" for extensions. In course of their duties in this line they have been drawn in and out of ducts up to nearly a dozen times, being subjected to all kinds of wear and tear in connection with this pioneer work, and are now as good as new so far as business qualities go. No other class

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of cable would have stood this kind of work so well. Needless to say, the cables were made by a good English firm, and it is unlikely that foreign-made, or even certain classes of British rubber cables, which are now being manufactured for selling at strictly competitive prices, would have answered as well.

A further method, which aims at displacing lead-covered and every other kind of cable, is a new solid system called the "Simplified." It consists essentially of bare copper conductors laid in a wooden trough, mechanically spaced and supported upon porcelain bearers; the conductors being entirely surrounded by a pitch compound to a necessarily much greater thickness than is used around ordinary cables. This method, although in principle an admirably simple one under the best conditions, must greatly depend upon the state of the weather when it is being laid, for its efficiency. It is necessary to prevent dampness from striking to the vitals of the system, and to keep away from the whole arrangement the presence of mud and other climatic accompaniments of ordinary solid-laying practice, which, however, cannot affect a previously insulated cable as they would a system which relies upon the effective *insulation* of the conductors as they are laid. Possibly such a system would be a prodigious success 'neath the blue skies of Italy, but at present there is little indication that in cost or efficiency, when laid under normal conditions in this country, much is to be gained over the stereotyped methods in vogue, except the absolutely glorious certainty of its being an electrolysis-free system.

The foregoing, it is hoped, deals fully and fairly with the chances of the lead-covered cables which have been used so extensively for electricity supply. It is of no use blinking the fact that, improperly made, laid or used, they stand rather a bigger chance of making history than do non-metallic sheathed cables; but the more strongly mechanical nature of the paper insulation is considered to be its advantage. This is particularly so when such cables are used with multiple conductors, where a solid separator is necessary to keep the tightly laid up strands of opposite polarities from approaching one another in the slightest degree. Especially is this mechanical factor valued in mains working at high potentials where decentralisation would be fatal.

So that for low-tension single-conductor cables the lead-covered type may be more generally displaced by the bitumen cable, but for concentric or multicore mains the lead-covered cable should hold its own, especially if reinforced by adequate testing and proper mechanical protection, together with sufficient bonding and earthing arrangements. It may be that the effects of perhaps temporary carelessness in regard to these latter precautions will produce results that will intensify the respect of mainsmen for a thoroughly protected system, so that the evil will be conquered by the very force of its own misdeeds.

And the writer hereby tenders his sincere sympathy, in anticipation, to those unfortunate persons responsible for the upkeep of electricity supply mains, who are now about to pass through the Valley of Sleepless Nights, and Murray's Formula, on account of those bonds which are *not*.

Some Methods of Increasing Central Station Business.

By HOWARD S. KNOWLTON.

WITHIN the past three or four years central station managers have become greatly interested in methods of securing new business, and the results which have followed the efforts of many companies to increase their output have been highly gratifying. In the early days of central station work the rapid development of equipment and well-nigh revolutionary changes in power plant design occurring at that period gave central station managers little time to campaign for new business along the lines practised so successfully to-day. The capacity of a plant was soon reached, for the mammoth generating units of these times were not in existence, and in some cases there was found a limit to the expansion of equipment through the addition of many small machines. New business steadily increased, but there was not that aggressive enterprise along systematic lines of advertising and demonstration which is now employed in the more progressive organisations.

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From an operating standpoint the advantages of increased output are many, especially if the demand can be distributed through a large part of the day, when in most plants a large percentage of the equipment stands idle. As was ably pointed out by Mr. A. W. Zahm in a paper read some months ago before the Iowa Electrical Association, current sold during this period of idleness is a very profitable class of business, and for this reason, especially low rates can often be quoted on certain classes of lighting and other uses of current, without discrimination of an unfair nature against other customers. The point to be kept in mind is the reduction of the ratio of the maximum output to the average. Mr. Zahm divides the field for increasing the output into four different classes—general illumination, power, decorative or advertising lighting, and heating. Among those entitled to specially low rates he includes churches, opera houses, and similar public gathering places, since these require a large quantity of current for a comparatively short period at a time when the station peak has dropped off; merchants who have been induced to keep their windows lighted until 11 or 12 p.m. for advertising purposes; electric sign lessees or owners; manufacturers, hospitals, hotels, and other customers requiring heat for special purposes during the hours when the lighting load is low; and miscellaneous power users. It is not the object of this article to enter into the question of rates, important as a reduction or modification in them is in its effect upon the station output. Rate problems must almost always be solved for the particular central station concerned, and although the rates in many plants resemble those in many others, it is important to base them upon the specific conditions locally prevailing, rather than upon what is being accomplished in other localities. Mr. Zahm's paper included a number of general recommendations as to rates which may be looked up by those interested.

One of the most interesting illustrations of central station advertising to be found in practice is the exhibit of the Edison Electric Illuminating Company, of Boston, on Head Place. Several years ago this company had an attractive exhibit of electrical appliances at the Mechanics' Fair in Boston, and the display proved so popular that it was decided to make the exhibit one of the permanent features of the company's practice. Quarters at Head Place were, therefore, fitted up with improved types of lamps, motors, and related machinery, and from this small beginning the exhibit has grown to remarkable proportions. It now occupies two rooms, which are practically filled with apparatus in workable condition, besides an office for the manager of the publicity department, and a storeroom. The attractions of the place have been extensively advertised in the newspapers, street cars, and elsewhere, the public being admitted without charge to what is really an up-to-date exposition of central station current consuming devices. Pamphlets describing the equipment are distributed freely. There are comfortable seats for visitors, and attendants are constantly on hand to explain the equipment to interested parties. The company also publishes a small monthly journal called *Edison Light*, which serves to keep its customers in touch with its progress. This is also given away to visitors, and there is a large mailing list of persons to whom the company regularly sends it.

The exhibits are classified under the following six heads: Electrical advertising, domestic appliances, electrical distribution, electric lighting, manufacturing and liberal arts, and electric power and ventilation. During the summer and fall the rooms were kept open from 9 a.m. to 10 p.m., but at present the closing hour is between 5 and 6. The exhibition of electric signs comprises many different forms, from simple sign letters to automatic flashing combinations, and from changeable signs to miniature lamp signs. Under domestic appliances are included a prepayment meter, heating pads, reading lamps, adjustable fans, electric stoves, tea kettle, chafing dish, water heater, flat iron, sterilizer, coffee pot, oven, broilers, foot warmers, soldering irons, stewpans, immersion heaters, curling iron, griddle, plate warmer, and other devices. The distribution exhibit covers meters, cables, wall boxes, switchboards and similar equipment.

The electric lightings exhibit includes various types of arc lamps, theatre dimmers, lamp replacers, adjusters and cleaners, turndown lamps, shades, brackets, adjusters, and other fittings.

There are many practical suggestions to the central station man in the folders and pamphlets given away to the visitors at Head Place. Some of these are published by the makers of equipment, others by the Edison

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Company itself. The manager, who runs his eye over these publications, is almost certain to find the advantages of different methods of using electricity succinctly stated for the public's benefit, which is exactly what he is likely to be interested in, in his own commercial territory. Thus, the circulars describing electric heating apparatus emphasize the flexibility of the equipment, its convenience, concentration of heat exactly where it is needed, and only while it is needed; the elimination of smoke, soot, poisonous gases, and danger of explosion common to other kinds of heating like alcohol lamps. The cost may or may not be a serious question, after these problems are determined. The quickness with which water may be electrically heated in the nursery and sick room, in hotels when travelling, in the parlour for afternoon tea, etc., is also emphasized. The convenience of electric flat irons, saving of time and wasted heat by their use, and the advantages of many other forms of heaters, are duly described.

One of the best of the Edison Company's publications is a small pamphlet setting forth the advantages of electric arc lights as contrasted with gas lamps. This pamphlet, entitled "Daylight at Night," points out in terse and positive language the vital features of the arc light. It briefly describes the factors which are taken into account when the company's experts make a plan for lighting a place, emphasizing the fact that considering the number of cubic feet adequately lighted the arc lamp is actually superior to candles, kerosene, or gas, at less cost of operation. Following this is a brief statement of the theory of light waves, with curves showing the close relation of the arc light to the sunlight, and the discrepancy between the latter and gas illumination. The pamphlet closes with a short discussion of the physiological effect of inferior lights and the relative distribution of illumination from gas lamps and enclosed arcs.

Small companies, of course, cannot usually afford to adopt the extensive schemes above outlined, in all their details, for securing new business. But it would certainly appear that something can be done, even if it is nothing more than allowing customers and others to visit the station, under suitable circumstances, and see the latest "wrinkles" offered for use by the manufacturers. It costs the company little to make such exhibits on its premises, as the manufacturer is usually glad to have this opportunity to display his apparatus. It costs the manufacturer little more than the fixed charges on his equipment as displayed. It is indeed a small and financially straitened central station which cannot afford to spend a little money in the way of advertising its business. Sometimes the daily press can be utilized to good advantage through short advertisements of new equipment or especially desirable apparatus of longer standing. The central station which can afford newspaper advertising might well follow the example of a prominent furniture house in Boston which advertises a single piece with consummate skill every few days, changing the card from time to time instead of inserting a single permanent advertisement.

Finally, it must be borne in mind that central station output cannot be greatly increased by advertising alone. After the prospective customer's attention and interest have been awakened, it remains to complete the transaction by giving him in succinct form the figures and facts which apply to his particular case. This may in some companies be performed by the advertising department, but in others, the services of many different men may be required to close the deal. The engineering department may be called upon to give the results of tests upon similar equipment to that proposed, or the auditing department may be needed to establish the cost of operation of a certain installation. The larger the company the more specialised will be its division of labor, and the results will be felt in securing new business. Central stations have made tremendous progress of late in acquiring motor loads, but the field is still open for progressive development, and will remain so as long as there is a chance for competition in the supply of power and light. Scientific illumination is still to be attained in many quarters, and the future undoubtedly holds radical improvements in store in reference to the production and distribution of artificial light.

Insignificant as the addition of a few lamps or motors may seem in proportion to the total output of a modern urban central station, it is the aggregrate of these units which makes up the total connected load, and which helps to make the business profitable.—*American Electrician.*

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*Central Station Management.**

By GEORGE S. CARSON.

THE recent remarkable growth of central electric-lighting stations can be attributed largely to the extension of power supply to the many small industries, extending over a large territory, which are operated through the medium of the high-voltage alternating current. These new conditions have complicated the question of business management and have led to new methods in the matters of distribution and sale of electricity. More responsibility is placed on the central stations on account of supplying this power, upon which many workmen are dependent, and interruption of the service means a serious loss to the user. It is, therefore, important that the station is properly equipped for good, continuous operation, not only to give good service but to do so ecomomically.

Managers often have much to contend with to operate at a profit under existing circumstances and must be always alert to keep down expenses and save wastage. Starting in the boiler room, the boiler equipment should be large enough to carry the load without crowding and designed to use the lowest grade of coal. The draught should be strong enough to burn this lowest grade coal, as it has been determined by test that the cheapest coal to burn is the cheapest you can buy. Bituminous slack coal at $1.45 per ton of 2,000 pounds with a stack draught of .25 in. of water will evaporate 1,000 pounds of water at 212° at a cost of 15 cents, while the cost in using the same kind of bituminous lump coal costing $2. 90 per ton is 24 cents per 1,000 pounds of water at 212° with the same draught and under the same boilers. This shows conclusively that it costs 60 per cent. more to use lump coal than slack where conditions and draught are sufficient to burn the slack coal. If the draught is not sufficient to burn this coal, then it is best to put up a steel stack of ample size. Here is one of the places where it is important to spend cents and save dollars.

The central stations have been used too much as experimental plants for the manufacture of the various types of electrical and power machinery, and it behoves the manager to be cautious in adopting any new appliance until after it has been tested several years in actual use and has demonstrated its durability and efficiency. If this rule is observed, the manager will steer clear of much unnecessary expense and trouble. Taking up the station instruments, it is advisable to give them tests for accuracy at regular periods to insure that the current is supplied at a proper voltage, and that all recording and measuring instruments are correct and can be relied upon as a check on customers' meters to ascertain current lost and unaccounted for. When we consider that one-fourth of all alternating current made and measured at the switchboard is "lost and unaccounted for" even under first-class working conditions, it will be seen that one of the most important questions of economy in central station management is to run down and stop this loss of current, which is all the greater because it is the finished product and has charged against it all station costs.

Experience has proved that most of the excess losses of current occur in antiquated small transformers and old-style meters. The finances of some companies may not permit of an entire change of meters and transformers at one time, but it will admit of a thorough testing of such apparatus. This should be done at the station or office of the company and not on the customer's premises, for the reason that it will cost less in the end to take meters down and test them where it can be done in a more thorough and accurate manner. Meters that cannot by repair be made accurate should be discarded, as it would be a reckless waste to have meters in use which are known to be slow. It is well to be careful in installing meters to use one adapted for the average current it is to measure, and not use a larger meter on a small load, a certain amount of which will then not be registered.

If a syndicate is contemplating purchasing a plant, the first question asked is, What are your gross earnings? They do not ask for your net earnings, and, I believe, care little, because their knowledge and experience enable them to judge on what percentage of earnings the plant can be operated and how much net earnings they can figure on making. Often stations are purchased which have proved a failure, and turned out a profitable investment just because knowledge and experience enabled great savings to be made

* *Electrical World and Engineer.*

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in operating expenses. When the equipment and other conditions are not favorable for the proper economy—and in most cases they are not—then a modern equipment is installed, the lines are all thoroughly overhauled and transformers and meters tested and inspected, and what was formerly a poor investment is transformed into a profitable one. I believe the whole matter depends first upon knowing what can be done and is being done in the best managed and equipped stations, and then by a system of records kept by recording instruments above referred to, to check just what current is lost each month and what price is received for all current sold and what price is received for all current supplied at the switchboard. By this plan any electric lighting station can increase its net earnings to a very large degree and many unprofitable plants put on a paying basis.

Considering the consumer's side of the business, it has always appealed to me that selling current to all consumers on the same basis of cost is the proper method. This can be done by taking a fixed base rate per kw-hour for all current up to the maximum demand of each consumer, which maximum can be determined by the number and candle-power of lights wired up, or by a current demand meter that registers the maximum current used in any given period of time, and on this maximum current charging the full base rate. For current used in excess of the maximum a much lower rate applies. This method of charge places all users of electricity on the same basis and it is, therefore, equitable to all. The consumer using light but one or two hours each day will pay a higher rate per kw-hour than one who uses light longer, the higher charge being made to cover the cost of fixed charges on the plant and readiness to serve, which must be considered an important part of the cost of operation.

The item of minimum bill should not be overlooked and can be arranged in proportion to the maximum demand of the consumer. The same rule can be applied to selling current for motor use by charging a certain rate for the maximum current used on a basis of two hours each day, with a much lower rate for all current used in excess of that amount, and with a monthly minimum bill for each horse-power of maximum demand in case the power is not used during the month—this charge being made to cover fixed charges on that much of the station equipment as the motor uses at maximum; or if the motor is used during the day only, then the minimum charge can be divided between the power and lighting load.

Where the voltage regulation is good, the Nernst lamps are proving successful on alternating current and are meeting the competition of the gas "arc" light with good results. The cost of maintenance of the Nernst is one-half per cent. per kw-hour on the 220-volt, two-glower and large lamps, which is about the same as the cost of incandescent lamp renewals. There is another feature of the business which we all must consider, and that is, the public are not serving the companies but the companies are the public. If every employee will bear this fact in mind and have a civil answer for questions and treat the consumers with the same consideration and respect which he himself would expect of others, a different feeling would be shown toward the corporation and and better relations would exist between the company and its patrons. The matter of looking after complaints and giving them prompt attention and just consideration is no more than should be done, as there is nothing so aggravating as to be turned down with a short, uncivil answer by some self-important clerk when a case is entitled to attention. These are, I believe, just as important matters in the management of the business as the economies of operation, and will have a bearing on the progress and growth of the business which has required much money and hard work to establish.

Important to Municipal Station Engineers.

Our July issue will be a Double Number, and will contain Illustrated Reports of the Annual Meeting of the Municipal Electrical Association, the Third International Electric Tramway and Railway Exhibition, and the Annual Convention of the Municipal Tramways Association.

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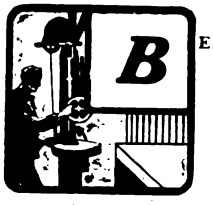
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Electrical artisans should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles on subjects of importance to themselves.

The Installation and Wiring Connections of Generators and Motors for Direct and Alternating Currents.

By STUART A. CURZON



BELIEVING that a series of descriptive articles in connection with above—showing the various connections met with in practical working—will be of use to wiremen, the writer intends giving, as far as is possible in the space at disposal, diagrams and hints of the most likely things to occur in the daily work of the installation hand.

Starting with the small D.C. machine, in its three methods of construction, and gradually working through to A.C. multiphase machines, every method in common use will be touched upon to some extent, with perhaps the possible exception of tramway motors and controllers, which may be dealt with hereafter in a separate series. While every endeavour will be made to ensure the ready understanding of the diagrams and descriptions, should any readers require further enlightenment the benefits of penny postage are applicable.

Finally, this series is not the outcome of the study of text books and trade claims, but of actual experience. It may be, therefore, that we may disagree, but practical application will demonstrate the exactness of the data given.

While types of machines and apparatus of various makes may be shown, the writer does not necessarily suggest that any particular make is the best, as this point does not usually enter into the province of journeymen electricians. For the same reason, details of construction and differences in design will not be touched upon.

The installation and general running of motors and generators are matters that every wiremen should have at his fingers' ends. Motors are now used in thousands, and while large and small firms alike can obtain current for power purposes at as low a figure as 1d. per unit, it is only in the natural way of things that their use should be vastly on the increase.

The small fan-motor now so commonly used for the cooling and ventilating of shops, offices, &c., needs but little description. The wiring conections are merely as for a lamp. Here we have the smallest machine in practical use. It is quite unnecessary to use any special starting device or regulator. Most desk and wall fans have a switch in the base giving three or more speeds by means of a resistance coil fixed to the pedestal.

Fig. 1 shows an outline of one of Verity's "Aston" fans, which has three speeds. Provided the current consumption does not

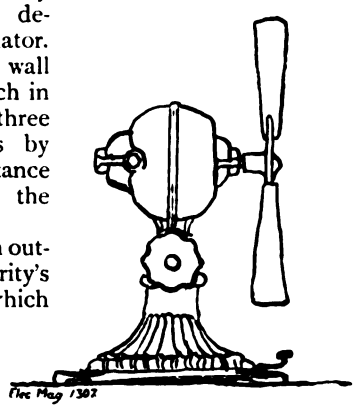


FIG. 1

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exceed 250 to 300 watts, small motors are perfectly safe when put straight on the main. An ordinary tumbler switch is sufficient control. An exception to this must be made if the pressure of supply is above 250 volts. It will sometimes be found, however, that specifications have to be conformed to, and a starter is a necessary adjunct. In this case it must be borne in mind that a "starter" has to be "over" to hold the keeper, and it cannot be used as a regulator for speed. It is advisable to use an ordinary regulator, which may be used as a "starter," but will remain in any set position. In either case, the wiring merely places the device in series with the motor (which is series wound).

When using a speed regulator, it is as well to fix a D.P. switch somewhat as in Fig. 2.

Passing over the small model machines used for such purposes as driving sewing machines, small lathes, &c., to which the above remarks apply, we come to the generator or motor that is the chief consideration of the electrician. First, we have the foundation or bed to which the machine has to be fixed. It is essential that this should be of sufficiently solid a nature to prevent the machine from excessive vibration. Dynamos and motors are delicate products, and are not to be handled as if care was unnecessary. For small machines up to, say, 7½ h.p., it is advisable to make a bed of concrete deep enough to reach solid support with a minimum of 2ft. Make some rough boxes, about 1ft. deep by 4in. square, and place in the concrete in the proper position for the hold-down bolts. The bolts

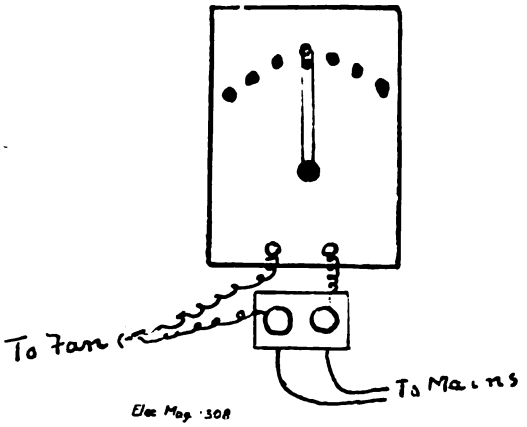


FIG. 2.

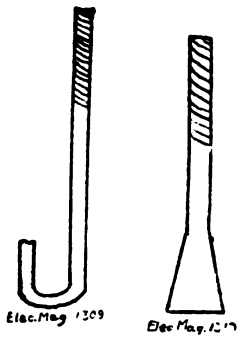


FIG. 3.

themselves may be of either of the patterns shown in Figs. 3 and 4. These should be grouted in when the machine has been lined up. Slide rails, or a moving belt-plate, are a necessity, so that belt slackness may be taken up. For larger machines it is better to take the hold-down bolts to the bottom of the concrete, leaving a hole 4in. square to the top. Fix a plate at the bottom of these in such a way that the bolts cannot turn when nuts are being tightened.

For these larger machines it is as well to have a stone slab on the top of the concrete bed. See that your dynamo or motor is perfectly level each way.

(*To be continued.*)

Notes.

WE seem to be entering into an age of miniatures. A journey round the various manufacturers' warehouses gives evidence that music-hall managers are not alone in their desire to obtain the "smallest on earth!"

It is not so long ago that the miniature arc lamp came into the field—and very successfully, too. We have miniature switches, plugs, &c., galore. The intending or likely purchaser is swamped in circulars of small telephones. This year we are promised an avalanche of miniature fans, and there is every reason to believe that they will "catch on." The most useful of these seems to be the one in cylinder shape, with ordinary B.C. terminals, which can be fitted into a lamp-holder, or placed on the stand supplied with cord and adaptor.

We have received a copy of "Modern Electricity," by James Henry and Karel Y. Hora (Hodder and Stoughton, 5s. net), which is, for the close student of electricity, one of the best books we have seen for some time. It is the sort of book to keep by you

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and spend odd half-hours with, if you want to obtain useful knowledge. The diagrams are good, and, in many cases, quite original, and will be of service.

We have also received No. 1 of *Eltradion*, which, while being the official organ of the Electrical Trades Union, is yet distinct from it. The Editorship is in the hands of Mr. Ewer, and, doubtless, his experience of the conditions of our trade, will make for its usefulness to those employed therein. At the same time, it is sincerely to be hoped that the "fellow-worker" tone, which seems so prevalent in this—the first issue—will gradually be eliminated in favour of more interesting things of a more instructive nature to wiremen, &c.

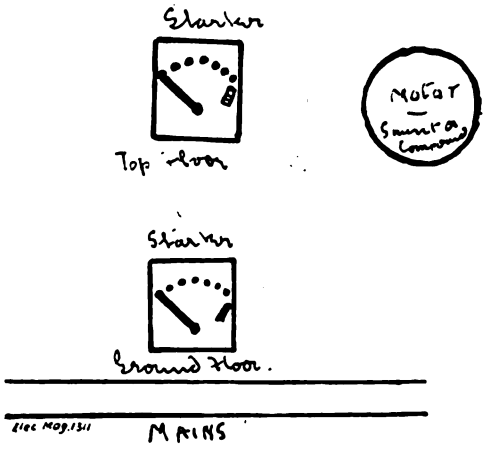
It may be interesting to note that some supply authorities—St. Pancras amongst others—are now objecting to the use of ordinary starting devices for motors. On what grounds is another question, and one that, I fancy, will require a wonderful lot of answering. The demand is for a slow speed starter. While supply engineers are, of course, quite justified, and to be commended for making stringent regulations, yet some show of reason is necessary. The suggestion that motor starters will be pushed straight over is taking people to be asleep to their own interests. Motors are too costly to be treated in that way, and I should like to know how many cases the framers of these rules can quote.

The contact or continuity nipple has now had a pretty fair trial, and its failures have been more freely demonstrated than its advantages. The Simplex Co.'s steel nipple is too liable to rust. The G.E.Co.'s nipple, being made of type metal, is void of any mechanical strength. Its chief disadvantage, however, lays in the fact that, when it was closed, the grip of the nipple on the tube was only at the end, as the screwing in only closed one end of it. This firm are about to alter the design of their continuity nipples, so that they will grip the pipe for their whole length. Of this, more anon.

Have we had your name and address yet? If not, take a post-card at once, and let us have it. If you don't, a few weeks will see you kicking yourself for having let a good opportunity slip by you.

PROBLEM No. 3.

This month we go from lighting, and No. 3 shows a query in motor wiring. The accompanying sketch shows us a motor fixed at the top of a building. It is desired to control this from two positions—one near motor and the other on the ground floor. The motor is to be shunt or compound wound. The ordinary type of automatic no-volts release starter is to be used.

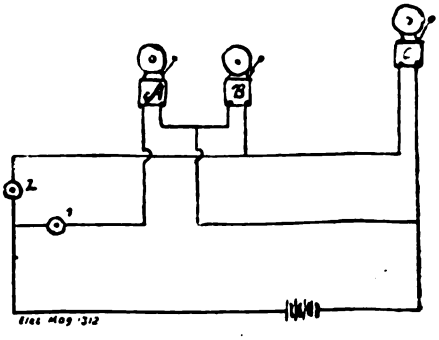


PROBLEM No. 3.

PROBLEM No. 4.

This is taken from a letter in the *American Electrician*, and is worth looking at. This sketch represents a bell circuit with three bells and two pushes. No. 1 is at the back door, and rings bell A. No. 2 is at front door, and rings both B and C. bells. A break occurred in one of the wires, the effect of which was that when push 1 was pressed the three bells rang in series.

Where was the break?



PROBLEM No. 4.

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"Haustelegraphie und Privat-Fernsprechanlagen."

(House Telegraphy and Private Telephone Circuits.) By J. NOEBELS. Leipzig: S. Hirzel.

The introductory chapters of this useful little work deal with the general principles of electro-magnetism, and include an account of the simpler electrical measuring instruments, the telephone receiver and microphone transmitter. Then follows a detailed description of the various forms of primary cell used in bell, telegraph and telephone work. The next section deals in a very thorough manner with wiring. The various accessories required in connection with bell and telephone work, such as pushes, bells, relays, &c., are then fully described. Next follow sections dealing with electric bell circuits, the utilisation of bell circuits for telephony, faults in bells and bell circuits; microphone transmitters, lightning protectors, complete telephone sets, switches and switchboards; junction lines for connecting private telephone circuits to public exchanges; disturbances in telephone lines, methods of testing and fault localisation; and rules and regulations of the German Post Office regarding telephone circuits. In an appendix the author deals with lightning conductors.

The book is written in a very clear and easy style, is profusely illustrated, and forms an excellent manual on the subject of electric bells and telephones.

"Das Elektrische Bogenlicht." Lieferund 2 and 3.

(The Electric Arc Light. Parts 2 and 3.) By W. B. VON CZUDNOCHOWSKI. Leipzig: S. Hirzel. 1904 and 1905. Price M.4 per Part.

Some time ago we had occasion to notice Part 1 of this work in these columns. It is a very comprehensive and entirely self-contained treatise on the subject, and may be read with interest by the general reader as well as by the technical man. In Part 2 the author commences the systematic study of arc lamps and their mechanisms. The history of arc lighting is considered under four periods, covering the years 1802-1844, 1844-1879, 1879-1900, and 1900 up to date, respectively. Part 2 deals with the first two and a portion of the third period; the author traces the gradual evolution of arc lamp mechanisms, dealing also with numerous other developments in electrical engineering —such as the epoch-making advent of the dynamo—which have influenced the history of arc lighting. Part 3 is concerned mainly with the important period 1879-1900. We can warmly recommend the work to all readers interested in the subject.

"Monographien über angewandte Elektrochemie: XVII. Hypochlorite und elektrische Bleiche."

(Hypochlorites and Electric Bleaching.) By Dr. EMIL ABEL. Halle-a-S.: Wilhelm Knapp. Price M. 4.50.

A monograph bearing the above title has already appeared as Part VIII. of the excellent series of volumes on applied electro-chemistry now in course of publication by Messrs. Knapp. It dealt, however, with the technical and constructive aspects of the subject, while the present work is concerned with the theory of the electrolytic production of hypochlorites. The author deals in a very thorough manner, and from an essentially modern standpoint, with the various changes which take place during the passage of a current through a solution of common salt. The various energy relations are carefully considered in the light of thermodynamics. The concluding sections are devoted to a discussion of the most favourable conditions for the electric production of hypochlorites, and of the part played by the electrodes in this connection.

"The Insulation of Electric Machines."

By TURNER and HOBART. London: Whittaker and Co. 10*s.* 6*d.* net.

The rapid progress made by the electrical industry has naturally led to the publication of numerous books dealing with the generation, transmission, and utilisation of electrical energy—however, this can scarcely be said of the section dealing with insulating materials. The subject is one which writers of treatises on dynamo-electric machinery pass over with a few words, the mere mention of several of the better-known insulating materials being regarded as sufficient. The book before us opens with a few introductory considerations, the first chapter consisting largely of lengthy foot-notes, culled from the proceedings of the several scientific societies, and from the technical Press, and these are a noticeable feature of the whole of the work. Everywhere one finds abstracts from papers and journals bearing directly on the point under consideration, and the busy engineer can master the subject without consulting many papers in several languages.

The insulation testing sets described are all open to one objection, *i.e.*, the voltage is raised by steps of several thousand volts, necessitating repeated alteration of connections. A much better method would be to feed the primaries of step-up transformers with current from the secondary of a regulable transformer. Chapter II. treats of the Properties of Insulating Materials; the influence of moisture, shape of electrodes,

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shape of samples, method of testing, temperature, ageing, and varying thickness being illustrated by a series of plotted results. Chapter III., on the Insulation on Magnet Wires, deals with cotton and silk coverings, and the tables showing the thickness of cotton coverings on standard armature and magnet wires should prove useful to the designer. Chapter IV., on the Disruptive Strength of Insulating Materials, is taken from a paper by Steinmetz, read before the American Institute of Electrical Engineers, and the results of the tests are expressed very clearly by a series of curves and tables.

In Chapter V., on Mica and Mica Compounds, the several grades of mica, micanite, megohmit, and megotale are described, and the disruptive strengths given. The influence of oil on these materials is discussed at some length.

Insulating Materials for Bushings, &c., are considered in Chapter VI., and from the illustrations given one sees the peculiar suitability of ambroin, roburine, &c., for this purpose. In the case of bushings and terminal blocks, mechanical strength is of more importance than electrical strength, and the figures given show that the materials are admirably adapted for the purpose. The notes on the working of ambroin should prove useful, as they apply more or less to all materials of this class. Chapter VII., on the Insulation of Commutators, opens with a few words on the requirements for effective insulation between the sectors, and green or amber reconstructed mica, milled to the required thickness, is recommended. The authors emphasise the fact that oil on the commutator ruins the insulation, and suggest vaseline or paraffin as a commutator lubricant. A good method is to apply a wax taper in the case of small machines, or a stick of hard-pressed paraffin-wax intimately mixed with graphite in the case of large machines, to the surface of the commutator. Insulating Varnishes, Oils, Paints, Impregnating Materials, and Heat Dissipating Impregnating Materials are discussed in the next three chapters, and in some places contradictory statements are made. On page 138, for instance, we are told to dilute armalac with benzine should it be too heavy in body, and on page 138 "mix nothing with armalac; to dilute (when made necessary by evaporation) only with petroleum naphtha."

The next two chapters treat of oils for insulating and oil testing. The effect of a very small percentage of water in the oil is fatal, and from a curve given on page 154 we notice that the addition of one-tenth of 1 per cent. of water reduces the disruptive strength to one-thirteenth of the value for dry oil. In view of this it is to be regretted that the writers do not give a method for detecting, and instructions for the removal of, the water. The section dealing with the testing of insulating oils is good.

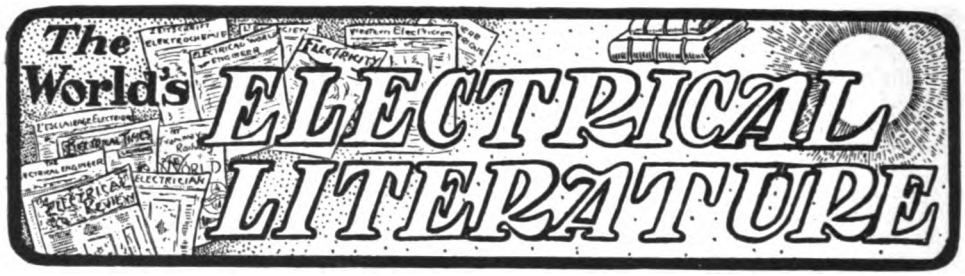
The Insulating Properties of Paper, Fibrous Materials, Celluloid, and Impregnated Cloths and Fabrics are considered in Chapters XII., XIII., and XIII.A, and the curves showing the relation between the thickness and disruptive strength should be of service.

The remaining eight chapters are useful; they deal with the insulation of machines after the material has been decided upon. Chapter XIX., on Taping Machines, and Tapes and Bands, is illustrated by a number of well-drawn figures and plates from photographs, showing the construction of taping machines. Vacuum Drying Ovens are described in Chapter XX., and a type of oven for drying only, or for drying, insulating, and impregnating, is shown in detail. Chapter XXI., on Other Tools, &c., Employed in the Process of Insulating, is in some respects disappointing. Seven plates from photographs taken in the works serve to illustrate the chapter, and five types of testing transformer are shown. In connection with the latter the following description is given: "*Familiar testing appliances are illustrated in Figs.* 141 *to* 145. *It is important to test the windings as frequently as possible during the various stages of manufacture.*" Surely this important side of the question should have been treated in greater detail. Chapter XXII., on Specifications for Insulation, is based largely on the work of the American Institute of Electrical Engineers and of Thomas and Parshall, and should be read by everyone interested in the subject. An admirable feature of the work is the Bibliography in Chapter XXIII. The references relate to the practical commercial applications of insulating materials, more especially to electric machinery and apparatus.

The work of the Engineering Standards Committee on Insulating Materials, carried out under Dr. Glazebrook at the National Physical Laboratory, is dealt with in a short appendix. A very complete index materially enhances the value of the work. In closing we must express our regret that the authors have not given a few notes for determining the thickness of the insulating material in a number of cases. In a future edition this may be done, and the value of the work, from a designer's point of view, will be much increased. It remains for us to say that the publishers have fully maintained the standard of the Specialist Series so far as the general appearance of the book is concerned; the paper, the type, and the illustrations are excellent.

H. H. B.

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The leading contents of the periodical electrical press of the world, papers read before Learned Societies, and any other literature treating upon electrical subjects are arranged *under subject-matter* in this section. Suitable references are made to the names and dates of the various papers, and the whole forms an index guide of considerable importance and value.

Power.

Articles.

*Electric Power for Refrigeration. J. C. Chamberlain.	*Elec. Wld. & Engr.* 1/4/05.
The Largest Electric Water Power in Maine.	*Elec. Wld. & Engr.* 8/4/05.
Power Installation of a Coffee-Roasting and Spice-Grinding Plant. H. S. Knowlton.	*Elec. Wld. & Engr.* 8/4/05.
*Electricity as Motive Power for 1,100-ton Cargo Boat. J. W. H. Hamilton.	*Elec. Wld. & Engr.* 15/4/05.
Electric Plant at Medellin, Colombia. G. H. Hines.	*Elec. Wld. & Engr.* 15/4/05.
A Norwegian Hydro-electric Plant. T. N. Schulz.	*Elec. Wld. & Engr.* 24/4/05.
Electric Crane at the St. Triphon Quarries, Switzerland. C. L. Durand.	*Elec. Rev. N.Y.* 1/4/05.
Electricity in the Anthracite Coal Mines. R. T. Kent.	*Elec. Rev. N.Y.* 8/4/05.
Lightning Arresters for Power Circuits. R. Scott.	*West. Electn.* 8; 15/4/05.
The Erection of Alternating-Current Machines. R. Scott.	*Power, Apl./05.*
The Variable Speed Motor.	*Power, Ap'./05.*
The 36,000-volt Hydro-Electric Installation of the "Cellina." E. Bignami.	*Elec. Rev.* 7/4/05.
Electric Winding Engines of the Tiremande Mines. A. Gradenwitz.	*Elec. Rev.* 14/4/05.
The Church Stretton Electricity Works.	*Elec. Rev.* 21/4/05.
*Protective Apparatus. N. J. Neil.	*Elec. Club Jrnl. April/05.*

Papers.

*Electrical Machinery Adapted to Long-Distance Power Transmission. F. A. C. Perrine.	*Brooklyn Poly. Inst.* 13/4/05.
Motors for Driving Machine Tools. G. H. Condit.	*Nat. Mach. Tools Assoc.* 11/4/05.
Power Capacity of a Running Stream without Storage. W. G. Raymond.	*Iowa Eng. Soc.* 1/4/05.
Standardisation of Motor Drives.	*Nat. Mach. Tools. Assoc.* 11/4/05.
The Relative Cost of Power for Belt-Driven and Motor-Driven Shops.	*Nat. Mach. Tools Assoc.* 11/4/05.
The Advantages of a Motor Drive and greater Power necessary in the Belt Drive for Machine Tools.	*Nat. Mach. Tools Assoc.* 11/4/05.
A.C. Motors in Industrial Service. P. D. Ionides.	*Glasgow I.E.E.* 9/4/05.

Traction.

Articles.

*Third-Rail Connections. W. A. Del Marr.	*Elec. Wld. & Engr.* 22/4/05.
Control of Electric Locomotives. W. Cooper.	*Elec. Rev. N.Y.* 8/4/05.
Rural Electric Roads. Dr. L. Bell.	*Elec. Rev. N.Y.* 29/4/05.
Car Designs and Carrying Capacity. J. P. Fox.	*Strt. Rly. Jrnl.* 1/4/05.
Station Stops in Rapid Transit Service.	*Strt. Rly. Jrnl.* 1/2/05.
The Operation of Automatic Electric Track Switches. S. Diamant.	*Strt. Rly. Jrnl.* 1/2/05.
Welded *v.* Fished and Bonded Railway Joints. W. H. Cole.	*Strt. Rly. Jrnl.* 1/2/05.
*Creating Traffic. E. P. Hulse.	*Strt. Rly. Jrnl.* 1/2/05.
*Overhead Traction for Single Lines in Europe. C. O. Mailloux.	*Strt. Rly. Jrnl.* 8/4/05.
Oerlikon Electric Locomotives. C. O. Mailloux.	*Strt. Rly. Jrnl.* 8/4/05.
*Is a Universal Type of Railway Motor Advisable? A. H. Armstrong.	*Strt. Rly. Jrnl.* 15/4/05.
Car Ventilation. E. Taylor.	*Strt. Rly. Jrnl.* 15/4/05.
Improvements on the Motor Cars of the Metropolitan West Side Elevated Co., Chicago.	*Strt. Rly. Jrnl.* 22/4/05.
Electric Railway Systems in Manilla.	*Strt. Rly. Jrnl.* 29/4/05.
Tramway System in West Ham.	*Trmwy. & Ry. Wld.* 6/4/05.
A Unique Private Garage at Minneapolis. C. H. Coar.	*West. Electn.* 6/4/05.
Antwerp Street Lighting System. C. Smith.	*West. Electn.* 22/4/05.
The Birmingham and Midland Tramways.	*Elec. Rev.* 28/4/05; 5/5/05.
The Stubaital Single-Phase Railway.	*Electn.* 5/5/05.

Papers.

*Tickets: Their Use and Abuse. F. D. Norval.	*Indiana Elec. Rly. Assoc.* 13/4/05.
The Alternating Series Motor. F. Creedy.	*I.E.E.* 13/4/05.
*Line Construction for Single-Phase Railways. T. Varney and G. A. Damon.	*Am. I.E.E.* 24/3/05.
Car Shop Methods. J. D. Fish.	*Iowa Strt. Rly. Assoc.* 21/4/05.
Rural Railways. F. McDonald.	*Iowa. Strt. Rly. Assoc.* 21/4/05.
Handling Freight by Inter-urban and Interchange of Business with Steam Railroads. H. H. Folk.	*Iowa Strt. Rly. Assoc.* 21/4/05.
*Progress made in Electric Traction on Important Lines of Railways.	*International Rly. Congress,* 7/5/05.
Experiments made with High-Tension Currents.	*International Rly. Congress,* 7/5/05.

Lighting and Heating.

Articles.

*The Occurrence of Tantalum Minerals. D. T. Day.	*Elec. Wld. & Engr.* 1/4/05.
The Use of Small Sized Carbons in Enclosed Arc Lamps.	*Elec. Wld. & Engr.* 15/4/05.
Municipal Arc Lighting in Columbus, Ohio. C. Wiler.	*Elec. Wld. & Engr.* 22/4/05.
*The Metallic Arc. T. Ladoff.	*Elec. Wld. & Engr* 22/4/05.
*A Field for the Illuminating Engineer. T. B. Marks.	*Elec. Rev. N.Y.* 15/4/05.
Electricity at the New York Hippodrome.	*Elec. Rev. N.Y.* 29/4/05.
Modern Arc Lamps. J. Howatt.	*Amer. Electn. Apl./05.*

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Papers.

*Improvements in Arc Lighting. G. N. Eastman.	*Chic. Am.I.E.E.* 4/4/05.
*The Use of Rare Earths in Electric Illuminants. M. C. Beede.	*Engs. Soc. West Penns.* 23/3/05.

Telegraphy & Telephony.

Articles.

Modern Telephony in Theory and Practice. W. H. Radcliffe.	*Tel. Mag. Apl.*/05.
The Best Method of Cable Splicing. W. Barnes	*Tel. Mag. Apl.*/05.
Telephone Subscribers Extension Circuits. H. P. Clausen.	*Sound Waves, Apl.*/05.
Efficient Lightning Protection. A. E. Dobbs.	*Sound Waves, Apl.*/05.
Line Testing. G. J. Newton.	*Sound Waves, Apl.*/05.
The Power Plant of a Modern Telephone Exchange. A. D. O'Brien.	*Amer. Electn. Apl.*/05.
Common Battery Telephone System. W. S. Henry.	*Amer. Electn. Apl.*/05.
Automatic Block Signals. R. Scott.	*Amer. Electn. Apl.*/05.
*New American System of Wireless Telegraphy. J. F. King.	*Elec. Wld. & Engr.* 15/4/05.
Artom Selective System of Wireless Telegraphy. A. L. Hollins.	*Elec. Wld. & Engr.* 22/4/05.
*Telephone Engineering. XV. J. C. Kelsey.	*Elec. Rev. N.Y.* 15/4/05.
Telephone Fires. F. Broadbent.	*Elec. Rev.* 21/4/05.
Electrical Repairs at Sea.	*Elec. Rev.* 28/4/05.
The London Wall Telephone Exchange.	*Electn.* 21/4/05.
Notes of the Effect of Electric Oscillations on Magnetism. L. H. Walter.	*Electn.* 5/5/05.
Intermediate Distributing Frame. K. B. Miller.	*Telephony, Apl.*/05.
Maintaining of Switchboard Cords. C. H. Coar.	*Telephony, Apl.*/05.
Telephone Construction Practice. F. J. Minhinnick.	*Telephony, Apl.*/05.
What is an Automatic Telephone System. W. W. Dean.	*Telephony, Apl.*/05.
The Best Method of Telephone Advertising. W. B. Woodbury.	*Telephony, Apl.*/05.

Papers.

Standardisation of Equipment. L. H. Clapp, O. F. French, and B. H. Brookes.	*Ohio Ind. Tel. Soc.* 30/3/05.
Practical Operation and Maintainance of Exchanges C. E. Stimson.	*Ohio Ind. Tel. Soc.* 30/3/05.
How to Increase Long-Distance Business. M. B. Overly.	*Ohio Ind. Tel. Soc.* 30/3/05.
Telephone Traffic. H. L. Webb.	*I.E.E.* 11/4/05.

Electro-Chemistry.

Papers.

Electrostatic Method for Separating Concentrating Ores. L. J. Blake.	*Amer. Elec. Chem. Soc.* 25/4/05.
Electrolytic Potential of Chromium. H. R. Cravath.	*Amer. Elec. Chem. Soc.* 25/4/05.
Treating Low Grade Ore and Tailings by Electrolysis. E. Fahrig.	*Amer. Elec. Chem. Soc.* 26/4/05.
Reversible and Irreversible Polarisation. W. S. Franklin.	*Amer. Elec. Chem. Soc.* 26/4/05.
An Optical Method of Observing Diffusion in an Electrolyte. C. Hamburchen.	*Amer. Elec. Chem. Soc.* 26/4/05.
Low Voltage Standard Cell. G. A. Hewett.	*Amer. Elec. Chem. Soc.* 26/4/05.
Specific Inductive Capacities, L. Kahlenberg.	*Amer. Elec. Chem. Soc.* 26/4/05.
Some Experiments on the Reduction of Titaniferous Ores into Steel and Titanate of Iron. A. Lodyguile.	*Amer. Elec. Chem. Soc.* 26/4/05.
Experiments on the Electro-Deposition of Metals on Aluminium. A. Lodyguile.	*Amer. Elec. Chem. Soc.* 26/4/05.
The Utilisation of Blast Furnace Gases in Connection with Electric Smelting. A. J. Rossi.	*Amer. Elec. Chem. Soc.* 26/4/05.
Electro-Deposition of Silver. R. C. Snowdon.	*Amer. Elec. Chem. Soc.* 26/4/05.
Aluminium Electrolytic Condenser. C. J. Zimmermann.	*Amer. Elec. Chem. Soc.* 26/4/05.

Electro-Physics.

Articles.

*Harmonic Analyser. G. H Rowe.	*Elec. Wld. & Engr.* 25/3/05.
A New Oscillographic Wave Tracer. R. Goldschmidt.	*Electn.* 14/4/05.
*Harmonic Analysis Reduced to Simplicity. S. P. Thompson.	*Electn.* 5/5/05.

Papers.

The Resistance of a Conductor the Measure of the Current flowing through it. W. A. Price.	*Phys. Soc.* 12/5/05.
A Bolometer for the Absolute Measurement of Radiation. H. L. Callendar.	*Phys. Soc.* 12/5/05.

Manufacturers.

Articles.

Flux Distribution in Design. A. Press.	*Elec. Wld. & Engr.* 8/4/05.
The Slip of an Induction Motor. F. Bailey.	*Elec. Wld. & Engr* 22/4/05.
*A New Method of Testing Alternate Current Generators. H. M. Hobart and F. Punga.	*Elec. Wld. & Engr.* 22/4/05.
Nitric Acid in Insulation of High-Tension Alternator Coils. C. E. Farrington.	*Elec. Wld. & Engr.* 22/4/05.
Loss due to Surplus Capacity in Transformers. J. S. Codman.	*Elec. Wld. & Engr.* 22/4/05.
A Practical Design of the Solenoid. C. R. Underhill.	*Elec. Wld. & Engr.* 29/4/05.
Line Effects due to a Moving Load. C. P. Nachod.	*Elec. Wld. & Engr.* 29/0/55.
*Tests to Determine the Comparative Heat Conduction and Radiation of Insulating Varnishes. J. C. Dolph.	*Elec. Wld. & Engr.* 11/4/05.
*The Manufacture of Electrical Machinery in Japan. W. Dinwiddie.	*Elec. Wld. & Engr.* 22/4/05.
*Considerations Relating to the Design of the Armature Slot Insulation in High Voltage Alternate-Current Generators. H. Hobart.	*Elec. Rev.* 28/4/0 5/5/05.

Papers.

*Labour-Saving Formulæ. J. Frith.	*Manch. I.E.E.* 11/4/05.

Central Station Practice.

Articles.

Labour-Saving Machinery in Central Stations.	*Elec. Rev.* 7/4/05.
*The Starting of Rotary Converters. S. Woodfield.	*Elec. Rev.* 21/4/05.
Valves and Valve Gears. III. R. G. Griswold.	*Power. Apl.*/05.
*Meter Department of the New York Edison Co.	*Elec. Wld. & Engr.* 1/4/05.
The Physical Comfort of the Operating Force and its Relation to the Cost of Production. P. Lupke.	*Elec. Wld. & Engr.* 1/4/05.
Transformer Practice. C. W. Humphrey	*Elec. Wld. & Engr.* 8/4/05.
*Single Wattmeter on Edison Three-Wire System. L. A. Freudenberger.	*Elec. Wld. & Engr.* 15/4/05.
Central Station Management. G. S. Carson.	*Elec. Wld. & Engr.* 15/4/05.
*Thefts of Current: How to Protect, Prosecute and Prevent. J. H. Hallberg	*Elec. Wld. & Engr.* 29/4/05.
Driving Two Alternators in Parallel. R. E. S. Geare.	*Elec. Rev. N.Y.* 15/4/05.
Grinding of High-Speed Commutators. O. H. Crossen.	*Elec. Wld. & Engr.* 29/4/05.
Electricity Meters. A. H. Gerhadi.	*Electn.* 14/4/05.
The Arrangement of Steam Pipes. R. T. Strom.	*Amer. Electn. Apl* /05.
Some Methods of Increasing Central Station Business. H. S. Knowlton.	*Amer. Electn. Apl.* /05.
Calorimetric Testing of Coal. G. T. Hanchett.	*Amer. Electn. Apl.* /05.

Papers.

Methods of Obtaining New Business. L. D. Methes.	*Iowa Elec. Assoc.* 19/4/05.
Boiler Room Economies. F. H. Lankashire.	*Iowa Elec. Assoc.* 20/4/05.
Methods of Accounting. A. W. Zahm.	*Iowa Elec. Assoc.* 20/4/05.
Steam Turbines. W. E. Boilleau.	*Iowa Elec. Assoc.* 20/4/05.
*Meter Data. A. W. Reavy.	*Iowa Elec. Assoc.* 20/4/05.
Lubricating Oils. J. H. Coste & E. T. Selbourn.	*Assoc. Engs. in Charge.* 12/4/05.
Stand-by Charges and Motor Load Development. A. M. Taylor.	*Inst. E.E.* 4/4/05.

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Electrical Work in the Shops.

Articles.

How to Remember the Wire Table. C. F. Scott.	*Elec. Club Jrnl. Apl.* 1/05.
Design and Construction of Small Dynamos and Motors. C. P. Poole.	*Amer. Electn. Apl* /05.
Diseases of Electrical Machinery. F. B. Crocker and S. S. Wheeler.	*Amer. Electn. Apl.*/05.
Factory Testing of Electrical Machinery. R. E. Workman.	*Elec. Club Jrnl. Apl* /05.

Articles marked with an asterisk are of exceptional interest, and well worth reading. Copies of any article or paper can be obtained on application to this office, a nominal fee only being charged for the clerical time occupied in taking out same. If desired, the whole publication will be procured (same not being out of print) on payment of the published price.

Where foreign papers have a similar title to those published in this country, the initial letters of the place of publication will be inserted after the abbreviated name of the particular paper; for instance, the English Electrical Review will be abbreviated Elec. Rev., and the American Electrical Review, Elec. Rev. N.Y.

New Catalogues.

POWER.

Motors.—THE ELECTRICAL CO., LTD., 121, Charing Cross Road, W.C. List No. 4, Section A, is a specification of one, two, and three-phase motors, which are made in semi-enclosed (protected), ventilated-enclosed, or totally-enclosed types. The windings and moving parts are also well protected from injury or accidental contact. A very complete description of the construction of the motors is given.

Electrical Equipments.—THE ELECTRICAL CO., 121, Charing Cross Road, W.C. A substantial publication dealing with electrical equipments for iron and steel works has reached us from the Electrical Co. Our readers will need no reminder of the special work which this company has carried out in this important industrial field. Fully illustrated descriptions of many large Continental plants which have been electrically equipped go to form a highly instructive and technically valuable publication, and one which might well be made the subject of careful study by British iron and steel masters.

Motor Installations.—J. H. HOLMES & CO., Newcastle-on-Tyne. Messrs. Holmes and Co. have an enviable reputation for the application of electro-motors to many and varied industrial purposes. Three of their publications have reached us dealing with numerous important installations of their motors in newspaper and printing offices, paper mills, engineering works, ship-yards, railways, and dockyards, and textile mills. For newspaper works the speciality of the company is the Holmes-Clatworthy system of driving, and of this we notice that no less than 3612 h.p. of motors are in active and successful operation. The printing installations aggregate 10,492½ h.p., while the plant supplied to paper mills totals nearly 420 h.p. In textile mills we observe that no less than 1612 h.p. of motors have been supplied and are in use, while the engineering works, ship-yards, and railways make up the grand total of 8214¼-h.p. From the same source has arrived a fully descriptive catalogue of the Lundell and Castle motors, which have been manufactured for a great number of years by Messrs. Holmes. This is a very instructive piece of literature, and should be in the hands of every power user.

Motors.—SIEMENS BROTHERS & CO., LTD., York Mansion, Westminster, S.W. We have received specification sheets giving particulars of G and A motors; the former are made in sizes up to 150 h.p., and the latter up to 60 h.p. The same types are also built for medium and slow speeds, and are manufactured throughout at the Stafford works of the company.

LIGHTING AND HEATING.

Fittings.—THE GENERAL ELECTRIC CO., LTD., London, Manchester, and Birmingham. The 11th edition of the Fixture and Glass Ware Catalogue is an exceedingly handsome production, well up to the high standard of the General Electric Company's publications. It is strongly bound in cloth, and contains illustrated particulars and prices of such accessories as cord grips, shade holders, wire guards, candle fittings, bead pendants, &c. Also details of reflectors, ship fittings, special fittings, pendants, brackets, ceiling lights, electroliers, standards, bronzes, and figures, street lighting fixtures, glass ware, and silk shades.

The Fittings Section contains some exceedingly handsome designs, which afford ample opportunity for a selection by the most exacting customer. A speciality is made of adjustable pendants with ceiling lights which should be very effective for dining rooms. The bronzes are of artistic conception and novel design, in addition to which there are plenty of them to select from.

CENTRAL STATION PRACTICE.

Cables.—CALLENDER'S CABLE AND CONSTRUCTION CO., LTD., Hamilton House, E.C. The comprehensive catalogue is just to hand from Messrs. Callender, and it is a veritable mine of information for Mains Engineers. Diagrams and specifications of Callender's Cables occupy a considerable portion of the publication, but in addition there are some ten pages of general information which should be invaluable in the management of distributing network. Further, there are thirty-six pages of feeder curves, which contain a great deal more information than they convey at first sight. The catalogue is strongly bound in cloth, and could easily be carried in the pocket.

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The

Electrical Magazine.

FOUNDED AND EDITED BY

THEO. FEILDEN.

VOL. III. NO. 6. (18th Issue.) LONDON. JUNE 27, 1905.

The World's Electric Progress.

This issue completes our Third Volume, and witnesses a most flourishing period in our history. In regard to the rapid progress of this journal the current number speaks for itself.

Modifications of the Magazine will be noticeable this month, and, we hope, will find approval. Essentially commercial matters are now and henceforward allotted distinct and definite space at the end of the text, and thereby separately focussed upon the attention of readers.

Our new programme is partly embodied in this month's arrangement, but with the first issue of the new volume (July) it will be fully realised. Special announcements for July will be found among the current literary pages.

Our Transport Supplement.

WE are pleased to present our readers this month with a Special Supplement dealing fully with the present aspect of electrical transport devices, more especially as concerns this country. With the co-operation of the firms whose specialities in this province are described, we have been enabled to illustrate types of the most modern of electrical transport machinery. We cannot impress too strongly the very great value of electrical power in this field, upon architects, builders, mine-owners, warehouse companies and large shipping houses. The rise and development of electrical transport machinery has been in some measure contributed to by the support of these captains of industry, but the task of the electrical pioneer of convincing them of the value of his devices has been no easy one. In the early days electric power was not readily available, and unless it was required on a large scale difficulties arose in persuading the small user to generate and employ it. Now, however, in extensive industrial areas, power mains are generally laid and it is a small matter to arrange for a connection thereto, even although current may only be required for a few months. In the case of large electricity works and collieries it is the most natural thing to convert the latent energy of coal into electrical energy, and there is now really no excuse for putting down steam plant.

Institution and Institute.

A COMPARISON of the past year's work of the Institution of Electrical Engineers and the American Institute of Electrical Engineers reveals a striking, not to say painful, redundance of purely theoretical matter in the proceedings of the former. It is really high time that the engineering element is at least adequately represented on the Council of the Institution, and that keener interest is taken by practical men in contributing to the papers and discussions. At the present time theory and practice are very badly balanced at the meetings of the central body; in fact, the latter is usually conspicuous by its absence. The meetings of the local sections may with justice be said to give each item its due; but even in the provinces, where manufacturing engineers are excused a journey to town, the same listless apathy is too evident. This

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amorphous condition of affairs is to be deplored, and we hope that the practical tone of the next session's meetings will be very materially improved upon. Our American friends are perhaps inclined to err in the opposite direction, but in so doing they really render a service to practical engineering and also to the general public. The subjects discussed during the past session have all had a direct bearing on the application of electricity for various industrial purposes and have provoked considerable discussion at the meetings themselves, while in addition public interest has been aroused. It is significant of American enterprise that provision of a commodious and handsome building for the Institute will very shortly materialise. A united engineering building which is to cost $975,000, and which Mr. Andrew Carnegie is presenting to the three great engineering societies, the Institutes of Mining Engineers, of Electrical Engineers, and Society of Mechanical Engineers, will shortly be proceeded with, the excavations having already commenced. It will be some time before the parent Institution at home will be in this happy position, despite the fact that its membership in 1904 exceeded that of the American Institute by 1730. We do not always like to point to America to show how things should be done, but in this case we cannot well do otherwise.

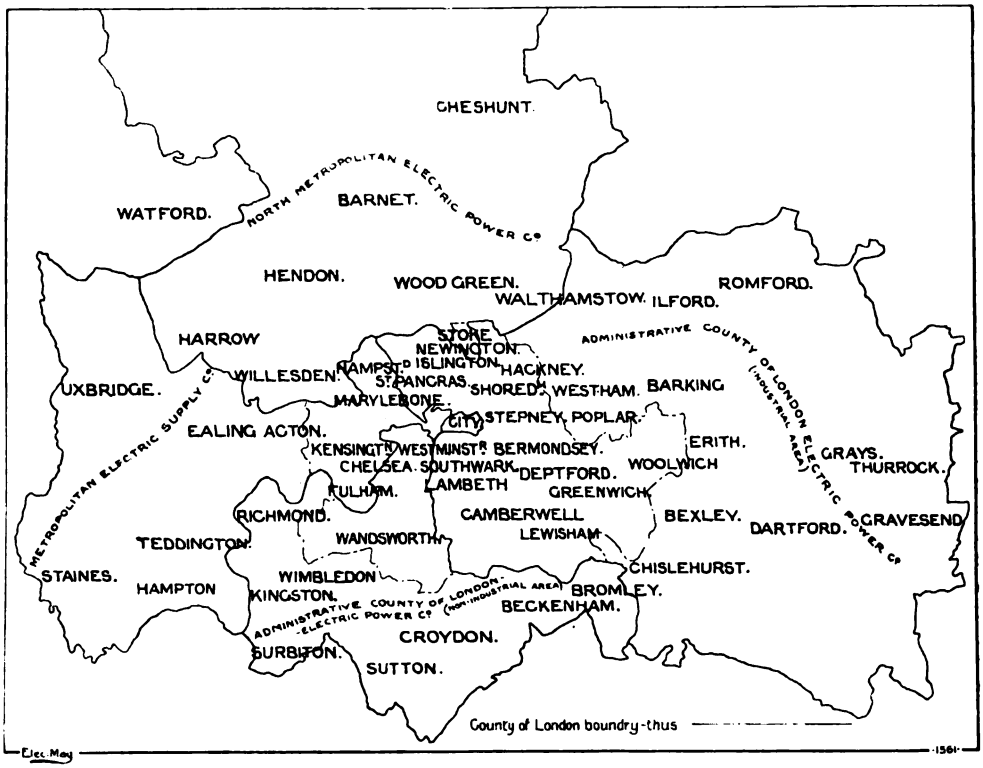


WIDNES-RUNCORN BRIDGE: VIEW OF SUPPORTING TOWERS AND TRAVELLER
(see Supplement at end of Magazine for description).

Widnes and Runcorn Bridge.

THE opening of the Widnes and Runcorn electrical transporter bridge completes a remarkable, and for this country a unique structure for the carrying of passengers and vehicles across a river. Suspended ferries, as this kind of bridge may be termed, are not uncommon in America and on the Continent, so that the Widnes-Runcorn example establishes no precedent in this instance. It has, however, a peculiar interest in that electric power is used to operate the transporter, and that that energy is derived from the cheapest known source—namely, from a gas driven power plant. A special illustrated description of the bridge and its accessories will be found in the "Electrical Transport Supplement" to the present issue. The inauguration of the service between Widnes and Runcorn by this novel transporter is happily coincident with the Supplement in question, and enables us the more appropriately to refer to it. For years the inhabitants of the towns and districts mentioned have been subjected to an irksome detour of some fifteen miles by road, if, for conscience' sake, they could not pay a bridge toll of 2d. each way, when they wished to visit each other. The bridge has cost some £130,000, but it must be remembered that this sum is far less than that which would have been needed for any other kind of structure. Moreover, the extreme flexibility and ease of control of electric power are the chief factors which have enabled the design of such a transporter to be practically realized. The consulting engineers, Messrs. Webster and Wood, are to be congratulated on the successful issue of their labours extending now over some four years, while the makers of the electrical plant and equipment, Messrs. Mather and Platt, must also be complimented on securing so important a contract and thereby upholding the still fair name of British electrical engineers.

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MAP SHOWING THE DIVISION OF LONDON INTO BULK SUPPLY AREAS BY LORD CAMPERDOWN'S COMMITTEE.

The Partition of London.

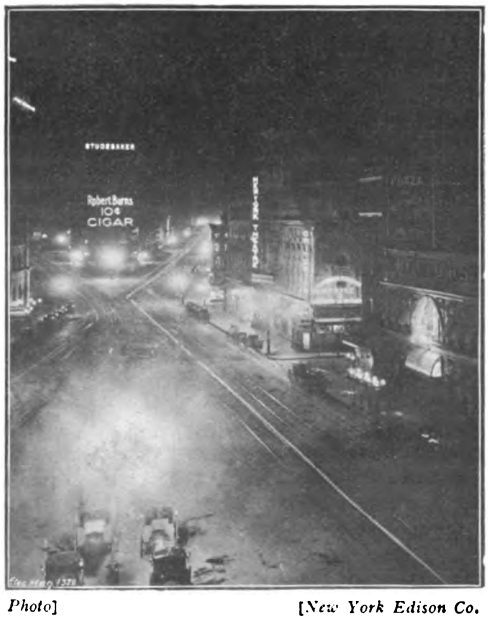
THE struggle in Committee with London's Electric Power Bills, has entered upon its second phase. From the wordy warfare and strife of tongues in Committee, only three companies worth mentioning have emerged with some semblance of their requirements remaining. The majority have failed to get through at all. Of the survivors, the Administrative County Bill almost naturally is best placed because its supporters knew what they wanted and what they intended to do. In Committee the opposition has been poorly engineered, and though a retreat on, and further entrenchment in the House, may repel the invaders, the initial encounter has witnessed the waste of much valuable ammunition, and a decided moral effect on the defenders. The map adjoining tells the tale of the victors and spoils as adjudicated by the Lord's Committee, and a few moments' consultation will explain the partition of the territory. The Metropolitan Electric Supply Company, it will be noticed, although exalted from the level of its fellows to the ranks of bulk suppliers, serves, by the paucity of its share in the plunder, to throw into bold relief the gargantuan proportions secured by the new comers, whose lot moreover is cast in pleasant places. The Tynesiders have not, however, come through thus far unscathed. Their demands have been pruned by a thoughtful Committee, and are accordingly more likely to pass muster in the final court of appeal. Due regard has been had for the liabilities of existing companies to municipal purchase in twenty-six years, and protection given accordingly Questions of supply in existing areas, of tariff, and of consent of authorised distributors have all been temporarily settled, and it now remains for the opposing companies and municipalities to try final conclusions with the "remnant" of the Committees in the House of Commons. A noticeable feature of the proceedings is the clearness with which the "trust company" makes its demands, and the attention it has paid to the smallest details of its own case. The unreadiness of the companies and the vapourings of the municipalities afford a striking contrast. Indeed it becomes more evident from the proceedings that the present

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suppliers have been caught napping, and will only fully awaken when they realise that they have been forestalled. Meantime the sooner the matter is settled the better for London.

Light Advertising.

Our American cousins are really patterns of smart advertising. In the comparatively narrowed and specialized field of electrical engineering they grasp the value of a well placed "ad.," and are keen to act upon it. We know of no better medium of publicity than *lux in tenebris*, and when properly handled, if one can use the term, it is immensely powerful in moulding public opinion "your way." Although electric signs are a source of great revenue to those who use them, they are, or should be, primarily a means to an end in central station business. We naturally look at the thing from a selfish standpoint, and want to come in "on the ground floor." In "Lighting and Heating" this month some pictures are given of what is done with the electric lamp in advertising in New York, and though we know they will commend themselves to our readers, we want to impress the fact that they were taken by the suppliers of the electrical energy, not by the sign-makers or users. Why? we hear some ask. Because they have the common sense to know that those pictures bring business. Electricity supply is not their pet hobby, run for public delectation and the pleasure of the strolling pedestrian. They have got electricity *to sell*, and now that their costs of making it are down at rockbottom, they mean to sell the same as Packman & Hobnail do, *by advertising*. Central station engineers have got to realise that they are in charge of a sales department as well as a manufacturing, and the sooner they wake up to it the better for electricity supply in this country. We don't want Faraday's and Maxwell's behind the electric supply counter, but a few Barnums and Whiteleys to boom the goods and build up the custom. We have something which wants proclamation from the house-tops, and there must be no *amour propre* in advertising.



Photo] [*New York Edison Co.*

View on Broadway, New York, at Night
(*see p. 509*).

The American Electro-Chemical Society.

A brief abstract is given in the electro-chemical section this month of the annual proceedings of the Electro-Chemical Society. Among the papers discussed we notice one especially relating to the utilisation of blast furnace gases for the electric smelting of iron. The author of this, Mr. A. J. Rossi, contended that the gases as at present utilised under boilers to raise steam are at least fully one half wasted. If this lost gas were employed to drive gas engines some 460 h.p.-hours would be procured for every ton of iron produced. The discussion raised strong criticism of the gas engine and voted it as very expensive, an instance being given in which a £4,000 gas plant was put down to do the work of a £250 steam installation. In this particular case also, the cost of operation was not lowered. On the other hand, several speakers favoured the gas engine, pointing to European practice, in which at the present time some 300,000 h.p. is obtained from waste gases. The remarks of Dr. J. W. Richards on the subject are of considerable importance. He stated that coal could be used in the blast furnace and the gases employed in gas engines for producing crucible steel at a lower rate than was possible by the older processes. With coal in the blast furnace only three per cent. of the calorific energy of the fuel was

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available, but when the coal is converted into gas for driving a gas dynamo, ten per cent. at least of this energy was obtained. In Dr. Richards's opinion the old processes for steel production are doomed in five years.

An Important Legal Decision.

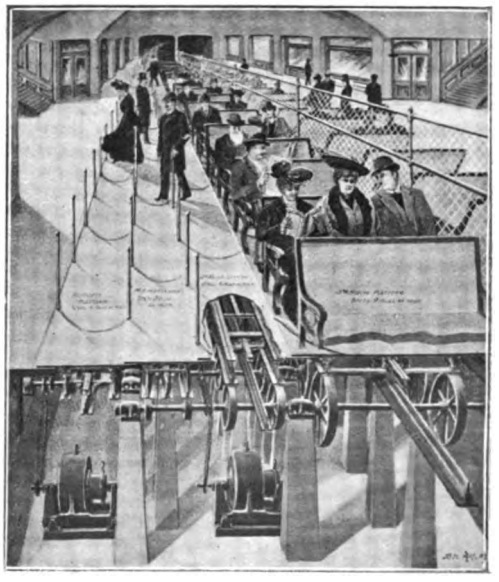
THE Royal Courts of Justice have recently witnessed the hearing of a remarkable case, and one which casts serious reflections on the industrial conditions at present prevailing in Italy. To electrical engineers accustomed to hear the praises of Italian electricians it will come as a shock to hear that labour-saving machinery is only installed at the dagger's point, and amidst scenes of bloodshed, at any rate in Milan if in no other part of the country. Italy is now world-famed for its use of hydro-electric power and no better or more certain economiser of labour is represented in that form of energy, but we have still to hear of its being generated and applied against any kind of opposition.

In the case referred, Messrs. Graham, Morton & Co., of Leeds, the plaintiffs, claimed £5,483 5s. 4d., as part of the contract price for an order value some £77,656 to erect 288 gas retorts at the Milan works of the Compagnie L'Union des Gaz. The defendants contended that the work was not completed, and generally proved unsatisfactory, a contention they could not, however, fully substantiate. For two years the work proceeded under the greatest difficulties, and only when payment was requested was a scurrilous accusation made that the plaintiffs had used inferior materials, and acted contrary to their contract.

During the operations the works had to be guarded, and the foremen carried firearms, while stabbing incidents among the labourers were quite common. Frequently work done during the day was wrecked at night, and every attempt was made to bring disaster to the installation. The judgment which was naturally in favour of the plaintiffs, with costs on the higher scale, makes very instructive reading, and should be in the hands of every contractor whose business connection extends to continental cities. In the space of a short note we cannot do the case justice, but we heartily congratulate Messrs. Graham, Morton & Co., in getting the best of a very bad piece of business.

The Moving Ways.

THIS title will recall to some of our readers the type of road pictured by H. G. Wells in "When the Sleeper Awakes" as developed by the artifices of an advanced age. The project, however, bids fair to materialize before the sleeper enters on the preliminary dozes of his protracted somnolence. New York contemplates a moving platform in a subway, though therefore not strictly according to prophecy, which will deal with the ever-increasing needs of its travelling public. That enterprising journal the *Scientific American* directly on hearing of the proposal materialized the scheme for its readers' benefit and one might almost imagine the thing had been done. We have reproduced from our esteemed contemporary,

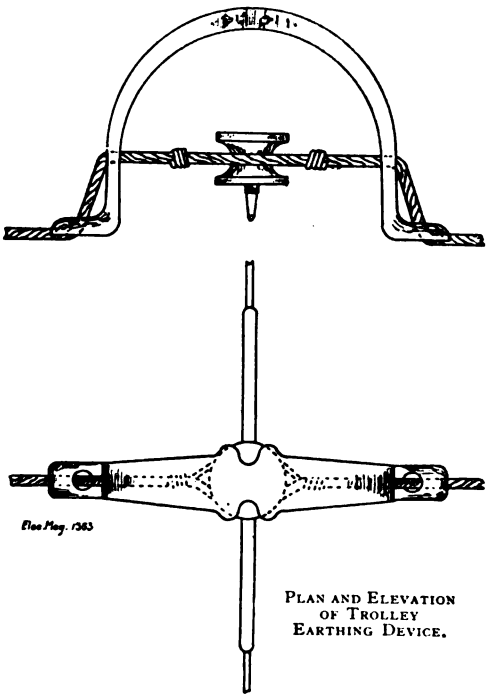


PROPOSED PLATFORM SUBWAY FOR NEW YORK.

though on a much smaller scale, what it conceives the moving platform will be. Those of our readers who hazarded a trip on the sample at the Paris Exhibition, 1900, will doubtless protest at the calm demeanour of the passengers stepping upon the intermediate platforms. The excitement of the transition was evidently not experienced by our American artist or flying coat tails and skirts and truant hats would have taken the place of the suave manner of his passengers. Perhaps we fail to appreciate the evenness of the American temperament under the most

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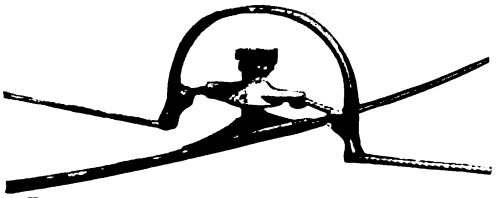
exasperating circumstances. But to return to that scheme. The subway is to be arranged in halves for the flow and return traffic, and each half is to be fitted with three moving ways, travelling at three, six, and nine miles per hour, with an auxiliary, running at the first speed for light traffic. The "stepping" platforms are provided with posts to assist the passengers in their transit over to the fast running strip which is fitted with seats. Motors are to be provided every 75 feet, and a much greater earning capacity per horse-power expended is anticipated over the ordinary method of transit. May this scheme soon get "pulled down" into the regions of practice, and a "section" put on the route we daily travel backwards and forwards to business.



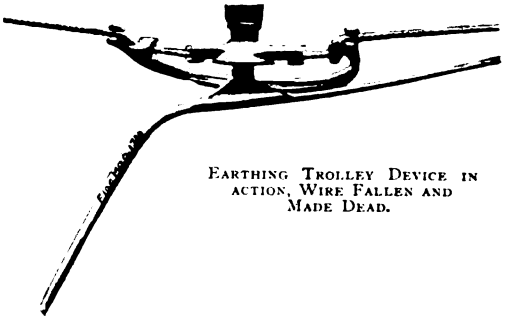
PLAN AND ELEVATION OF TROLLEY EARTHING DEVICE.

A Trolley Earthing Device.

THE name of trolley earthing devices is legion, and the names applied to such as have reached the practical field might be said to be likewise, were it not for the limitations of language under certain extenuating circumstances. Another of the genus has been brought to our notice, which, however, has the element of simplicity to commend it. It might, in comparison with some other specimens of the same ilk, be described as resembling, in its scarcity of parts, the helmet and three mosquitoes of a certain Central African explorer. The photos and sketch given on this page explain the device at a glance, and little or no description is needed. A metal hoop is fitted with lugs and notches, so placed that the passage of the suspension wire through them and round the trolley ear insulator exercises a strain tending to keep the hoop upright and clear of the trolley wire. Should the wire from any cause break and fall, this balance is upset, and the hoop kicks smartly over, and being earthed promptly brings out the feeder "breaker" at the station or substation, thus making dead the loose end of the wire, now hanging in a dangerous position. The photos explain the action of the device and show its positions for the sound and broken wire. We understand that lateral impulses which may at any time be given to the overhead suspension system, whether it be span wire or flexible suspension on brackets or centre poles, have no effect on the device, and it has no tendency to cant over unless the wire breaks either on one side or the other of it. The photos and sketch have been kindly placed at our disposal by Mr. Arthur Green, the inventor, who has also entrusted to our care a small working model which we shall be delighted to show to any tramways engineer who may be interested in the device. We may observe that it has been provisionally protected by the inventor, and has also been subjected to exhaustive tests.



TROLLEY EARTHING DEVICE IN NORMAL POSITION—WIRE INTACT.



EARTHING TROLLEY DEVICE IN ACTION, WIRE FALLEN AND MADE DEAD.

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Readers are referred to the World's Electrical Literature Section at the end of the Magazine for titles of all important articles of the month relating to Power, its Generation, Transmission, and Distribution.

Montreal's Hydro Electricity Supply.

By J. A. BURNETT.



FROM the manufacturer's standpoint, Montreal is one of the favoured cities of the world. The lavish hand with which Nature has bestowed power upon it should make it the manufacturer's Mecca in the immediate future. Readers of this journal will already be familiar with the electrical features of the hydro-electric plants now furnishing Montreal with light, heat, and power, and it will perhaps be interesting to briefly refer to the large station in Montreal at which the transmitted energy of the three power-plants—Shawinigan, Chambly, and Lachine—is received, and from which it is distributed. The adjoining map (Fig. 1) gives an excellent idea of the location of these plants and in some measure indicates the great water-ways which have been so successfully harnessed. Of the three rivers drawn upon, the St. Maurice alone drains an area of approximately 18,000 square miles, while the St. Lawrence and the Richelieu are backed by the Great Lakes. The receiving and transforming station in Montreal is built at the corner of Queen and Wellington Streets, and readers of the American Tour Souvenir Issue of THE ELECTRICAL MAGAZINE will recall the visit of the delegates to it on September 7th, 1904. The building measures 118 ft. by 123 ft., and is of brick. Figs. 2 and 3 are views of the interior taken from opposite ends of the station. To safeguard the joining property in case of fire, adjacent buildings are kept at a minimum distance of 73 ft. from the station building. Three-phase current is received at 5000, 25,000, and 50,000 volts respectively, and the higher pressures of these are reduced by step-down transformers of the air-blast type. These and the blowers for supplying the cooling air can be clearly seen in Figs. 2 and 3. Ten transformers, each of 2750 kw. capacity, are installed and each weighs 24 cwt. The

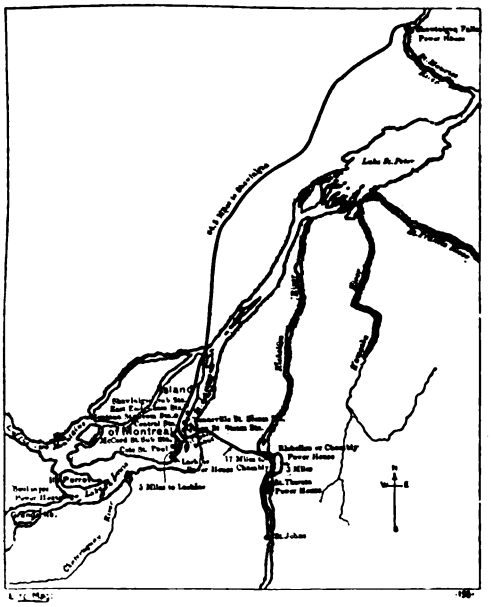


FIG. 1 MONTREAL POWER SCHEME: MAP OF TRANSMISSION LINES.

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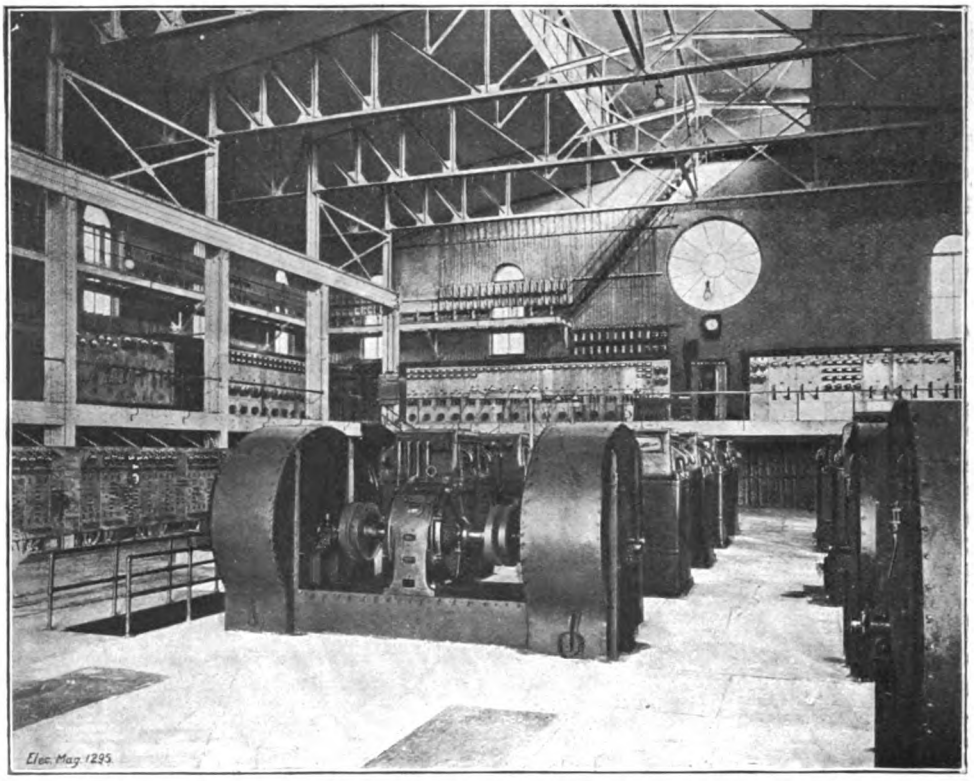


FIG. 2. INTERIOR OF CENTRAL STATION, MONTREAL, SHEWING MOTOR-DRIVEN BLOWERS AND SWITCHGEAR.



FIG. 3. 2750 KW. TRANSFORMERS, MONTREAL CENTRAL STATION.

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station has been designed for 16 transformers of the type shown, giving it an ultimate transforming capacity of 44,000 kw.

Three sides of the station are devoted to the switch gear, which is arranged on the ground floor and a gallery. An upper gallery is also provided for the lightning arresters of the 2400-volt distributing circuits, all of which are overhead. In addition to the main controlling boards is a large board for the series arc lighting, and for this the station contains a number of 30 to 50-light automatic regulators, the total number of arc lamps being 1717. Figs. 4 and 5 illustrate the extra high tension three-core cable used to carry the 50,000-volt three-phase current from the overhead transmission line four miles outside Montreal. Each conductor has a cross section of 211,000 cm., and the three leads are assembled as shown.

It is interesting to note that the Montreal Light, Heat, and Power Company has installed air-blast transformers at its central distributing station. Considering the location of the building within the city area, this policy has everything to commend it, because in case of fire the trouble is unlikely to spread beyond the damaged transformer. At Shawinigan, however, the step-up transformers are all oil-cooled, but a special device has been fitted by which in case of overheating the oil is displaced from below by water, and only under exceptional circumstances could fire spread to adjoining apparatus or buildings.

The Montreal Light, Heat and Power Company has an extensive area to supply and abundant power sources with which to serve it. Since the consolidation of some eight companies previously vested with rights of supply, the work of pushing the sale of electrical energy has proceeded apace, and as a result a magnificent combination of power sources has been turned to better use. Some 15 municipalities, all, with the exception of two, on the island of Montreal, encompassed by an area of 56 miles, are

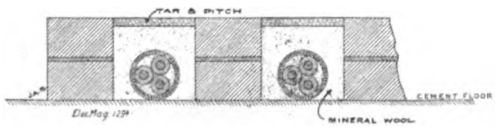


FIG. 4. 3-CORE CABLES LAID IN DUCT.

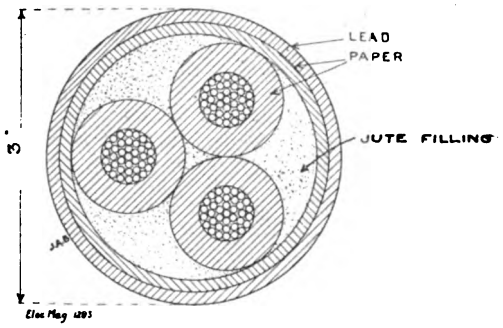


FIG. 5. SECTION THROUGH 3-CORE 50,000-VOLT CABLE.

within the supply "district," giving the company nearly 12,000 consumers. Approximately 300,000 incandescents are connected to the system and upwards of 20,000 h.p. in motors. A striking feature is the exceptionally high load-factor, this being a minimum of 74 per cent. in the summer and 76-77 per cent. during the winter. These results are traceable to a special tariff policy adopted by the company. A very attractive rate for power is in vogue during the winter months, by which current for power is not taken between 4 p.m. and 7 p.m. For the year 1903 the total output of the entire system was not far short of 85,000,000 kw. hours.

The plant at Lachine Rapids is unique in many ways, and illustrates how power can be obtained from falls as low as 16 ft. The engine room, which is 1,000 ft. long, stretches across the river from bank to bank, and the turbines are coupled in sets of six to lengths of shafting with generators at one end. The plant operates in multiple with that at Chambly, the frequencies of both stations having been altered by speed adjustment to 63 cycles. The total capacity at Lachine is 6,000 kw.

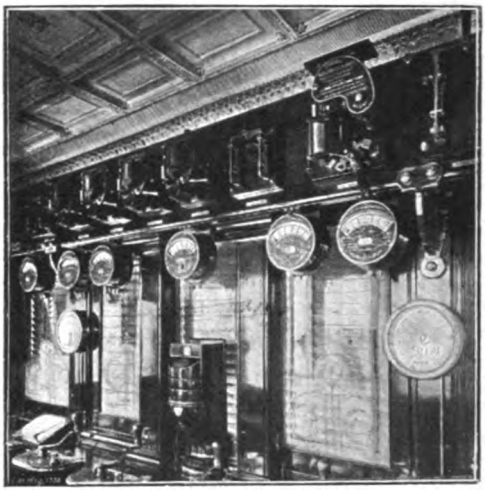
The task of consolidating a number of scattered supply plants, each equipped with different types of machinery, must have been a collossal one, and the engineers upon whom these labours fell are to be complimented on the results. The effects of an early use of a great variety of plant will doubtless require to be lived down, but the introduction of modern designs of machinery both for generating and utilising electrical energy will in the case of the system mentioned make it without rival among the world's hydro-electricity schemes.

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Electric Bridge-Swinging.

THE application of electrical power for bridge-swinging purposes has been very successfully illustrated in the case of the Pyrmont Bridge, which crosses Darling Harbour, in Port Jackson. The bridge is a light and handsome structure of iron and stone, having a length, including the approaches, of 1,758 feet, the covering being 1,200 feet, of which 223 feet represent the length of the swing span, the area of the latter, 12,000 superficial feet, comparing favourably with that of the 10,600 feet of the Newcastle-on-Tyne bridge-swing, the 9,400 feet of the swing-bridge in connection with the Manchester ship-canal, and the 8,700 feet of the bridge-swing at Hawarden.

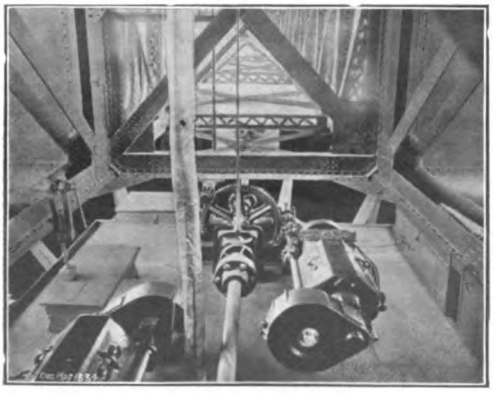
Both the slewing and lift motors, of 50 h.-p. each, are carried on a platform inside the drum and worked through a train of cut gears, two vertical shafts on the lower end of which are cut steel pinions meshing with a cast steel rack screwed to the top of a pivot pier. Each of the four gates on the side spans is operated by a 5 h.-p. motor. The operating of the gates is controlled by the man in the controlling house in the centre of the swing-span, who can see on a dial the position of the end lifts and that of the ends of the span when open or closed, all the mechanical tell-tales being placed in the building. The bridge and approaches are lighted with large arc-lamps, whilst red arc-lamps are placed on the end of the projecting platform to guide vessels through the swing when opening at night. The bridge was opened on the 28th June, 1902, and during the two following years the swing span has been opened 12,317 times for the passage of 21,818 vessels, the cost of each operation being three-farthings. The record number of openings for one day of twenty-four hours was thirty-nine for the passage of seventy vessels, the total cost of the electric current during this period being 2s. 5d.



BRIDGE CONTROLLING GEAR.



CONTROLLING HOUSE.



MOTORS AND GEARING.

ELECTRIC POWER FOR TRANSPORT.

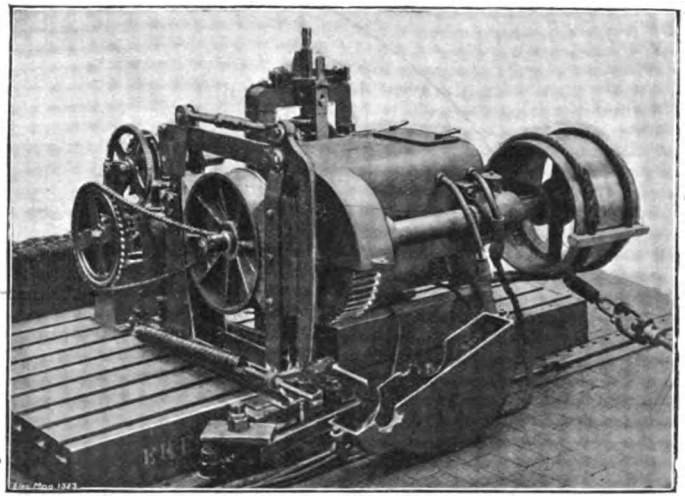
The use of Electric Motors for Transporting Devices is specially treated in our Supplement this month.

READ IT!

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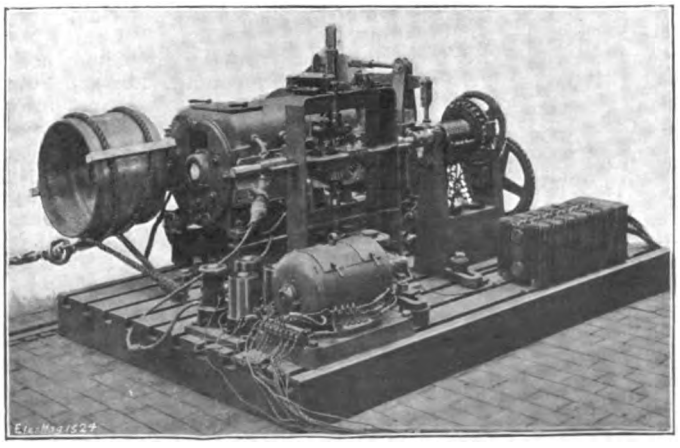
Electric Steering for Vessels.

THE extreme flexibility of electric power is exemplified in its recent application to the steering of vessels, a species of mechanical effort hitherto entrusted to steam. The Midland Railway Company is certainly determined to maintain its reputation for considering the comfort of its patrons, judging by the equipment of its latest steamer, *The Manxman*. This vessel, in addition to being driven by turbines, which practically eliminate vibration, is fitted with electric steering gear, which supplements the steam apparatus installed for the same purpose.



MAIN STEERING MOTOR, SHEWING BRAKE AND RELAY HUNTING SWITCH.

Smoothness of running is thus ensured for the steering gear when the electric drive is in use, and passengers will not be troubled with the clatter of the steam-steering engine, which always seems to be knocking itself to pieces. The regular motion of the electric motor drive, however, dispenses with these annoyances. The adjoining photographs depict the main driving and controlling mechanism as ready for installation for electric steering on *The Manxman*. In Fig. 1 may be seen the main motor; the brake gear and a portion of the controlling apparatus, and Fig. 2 is a view of the same mechanism as seen from the opposite side. A main driving motor is coupled to the steering worm-wheel on the opposite side to the steam engine, and controlled from electro-magnetic switches, which are placed in circuit by motor operated or "hunting" switches as they are termed. The steam gear is also controlled by electrical means, a small motor turning a spindle connected to the main valve. The same motor can also be changed over to actuate what is known as a relay hunting switch, which controls the circuits of the main motor. A combination of control has been arranged; for instance, both the electric and steam-steering gears can be controlled by hand from the navigating-bridge, or both can in turn be actuated from the same spot by the electro-motors mentioned. The action of the electrical control is entirely automatic, after the cycle of motions is once started by the pilot on the bridge. Safety devices, in the shape of electro-magnetic switches, are fitted to the rudder-motion, so that it is impossible to overwind either with the electric or steam-steering mechanisms. Another safety switch is mounted on the steam steering engine, which cuts off the actuating and controlling motors when the steam valve has been fully opened, to obviate the risk of injury to the valve.



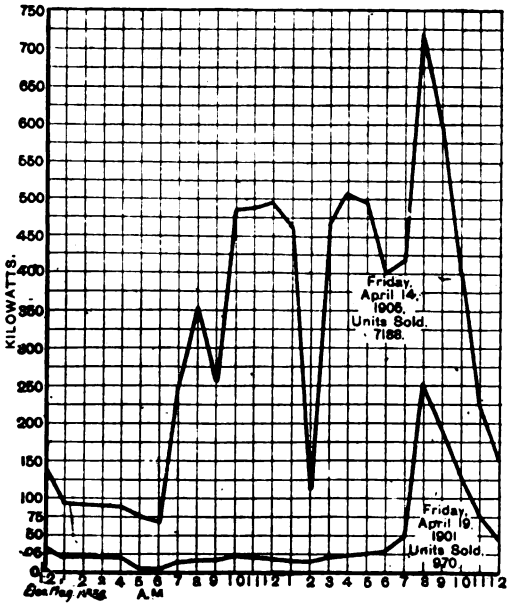
MAIN STEERING MOTOR, SHEWING ACTUATING MOTOR AND CHANGE GEAR

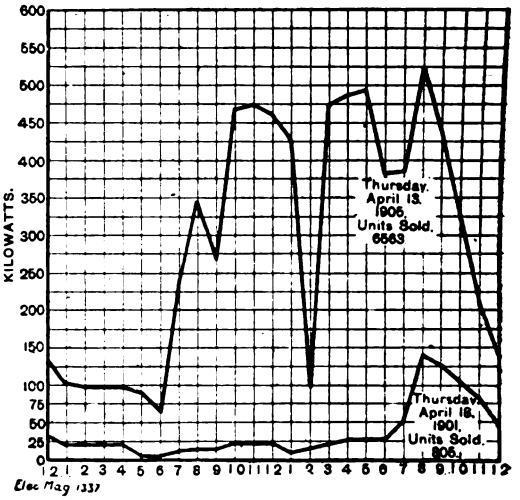
We are indebted to Siemens Brothers and Co. for the illustrations, and may mention that the apparatus was installed by them.

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Cheap Industrial Electric Power.

IN a paper recently read before the Birmingham Electric Club, Mr. J. A. Jeckell made out a good case for the supply of cheap electrical energy for industrial purposes. Incidentally, we must compliment the Club on the useful and practical character of the papers read at its meetings. Mr. Jeckell led up to his subject by reviewing briefly the developments responsible for the present position of the electricity supply art. In the course of this survey he remarked pointedly that "the number of consulting engineers who have actually designed, put down, run, and made a commercial success of an electricity supply station, was, and is, limited." The changes which came over the design of central-station plant were touched upon in turn, and the importance of economy emphasised. Capital outlay on small day-load plants was deprecated and supported by figures indicating the wide range of economy possessed by two 200 kw. sets at South Shields, which showed an average consumption of water of 23.74 lbs. per kw. hour. Mr. Jeckell's arguments are a direct appeal to urban electricity works managers, with stations similar to his own at Coventry. He is emphatic on the point of *cheap* power. In reducing works' costs to sell at a low figure he considers capital cost a secondary matter, the chief item being the coal consumption. In fact, he argues for proper commercial management of the undertaking. Despite the





obvious disadvantages presented at Coventry no less than sixty-four towns have higher works' costs, the places quoted having in most instances much greater output and facilities for custom. Many of the towns quoted have a very much larger output than Coventry, and several have a much better load factor, while quite a number are better situated with regard to coal supply, consequently it is quite fair to assume that had they all been designed on a broad basis, and managed commercially, the average cost would not have exceeded that of Coventry, where there are no special advantages, and one-third of the plant might be considered obsolete. The total saving which might have been effected in the sixty-four instances quoted amounted to £731,873. The acccompanying curves speak more graphically than words, of Mr. Jeckell's excellent work at Coventry. The works costs have been reduced from 3.43d. per unit in 1900 to .85d. per unit in 1905. In his concluding remarks, Mr. Jeckell succinctly sums up the situation: "I think no words of mine are necessary to show how great a success has been obtained by adopting what we may call ordinary commercial methods in dealing with a Corporation undertaking. Among these I mean the obtaining of orders and the treatment of customers. If we had waited for orders to come to us we should have had practically none. If orders would come in without being looked after, why is it that hundreds of thousands of pounds are paid every year to people who obtain orders?"

STATION MANAGERS.

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A classified list of Traction and Transport articles will be found in the World's Electrical Literature section at end of magazine.

One-phase Railway Motor Matters.

By MERCURIUS.



CONSIDERABLE space was devoted in the last issue to high-tension overhead construction for one-phase railways, with particular reference to what the American Institute of Electrical Engineers had to say about it. From the May *Proceedings* of that body now to hand, additional "talk" on the subject is available which puts the discussion on Mr. Creedy's recent paper into the shade. That is from the practical standpoint, though it is hardly fair to compare discussions on line construction and one-phase motors for railway work. From the remarks dropped at New York it is clear that the speakers had both thought and done things at home, and had gone abroad as well to see how things were done there. This fact might be noted by members of the Institution. At the A.I.E.E. meeting the good and bad points of existing lines at home and abroad were fully discussed, and the Valtellina line naturally was strongly focussed upon. It transpired that the span-wire supports for the trolley wire installed at the outset are now being discarded for the double catenary suspension, two messenger wires serving to carry both contact conductors. The insulation has been lightened, and iron girders at 130ft. intervals span the track and support the messenger wires, there being attachment points every 63ft. The block signal system is interconnected with the contact conductors, and a train at once cuts off the high-tension current if a danger signal is passed. Conductors over yards and stations can be also isolated by the signalman, though the expresses lower their trolleys and coast over these "dead" lengths. Troubles of various kinds, none serious enough to interrupt the service, have been experienced and complacently overcome as they arose. The trolley roller, for instance, was originally of copper, but now steel rollers copper-plated are found more serviceable, giving 10,000 to 20,000 kw. per roller before replating is needed. The Huber contact system, referred to last month, met with a mixed reception, one speaker giving prominence to difficulties unnoticed in the papers under discussion. The rectangular frame carrying the contact-maker was not automatic in its adjustment, and the contact-maker itself was badly scored on the

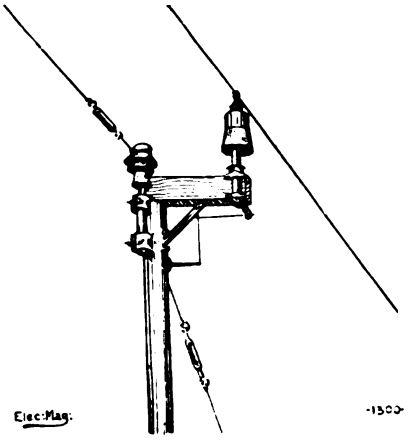


FIG. 1. SINGLE WIRE RIGIDLY SUPPORTED.

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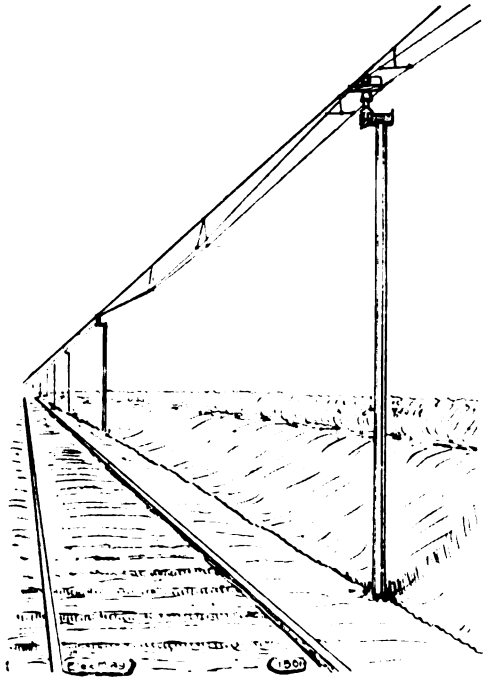


FIG. 2. "INVERTED" CATENARY SUSPENSION.

experimental line. As the device was under test, and indicates a principle rather than a practical apparatus, such condemnation was unmerited.

The work of the Oerlikon Company with the Huber contact-maker and supply wire was fully explained by Mr. C. O. Mailloux, who illustrated his remarks by lantern slides. The photographs were reproduced in the *Street Railway Journal*, from which the drawings adjoining have been made. Fig. 1 shows the single wire held by wire holders rigidly supported, and Fig. 2 is a view of the inverted catenary suspension, which has proved quite satisfactory. On the Seebach-Wettingen line, 20 km. long, which is being equipped by the Oerlikon Company, a block system is being installed which isolates any section in which the insulators fail from any cause. The H.T. switches used for this purpose are shown in Fig. 3. Mr. Mailloux had gone over the line with Mr. Huber, and, after carefully studying the many advantages of the top contact method of collecting current from a stationary wire, had become a convert to it. Of the speakers at the meeting, Mr. A. H. Armstrong made some practical remarks on trolley voltages. He averred that 5,000 to 6,000 volts was quite ample for a traction system to give low costs, and higher pressures might involve risks of breakdown and increase the capital outlay. As to supports for the line, it did not appear that more than one or two were needed between the poles. Feeders to sub-stations should not be separated, and radiated from the station as suggested, because trouble with transmission lines was found by experience to be proportional to the length of the lines. The meeting ended with congratulations to the Ganz Company for its pioneer work, and with subject much in the same position as when proceedings commenced. Standardisation was still impossible, and experiments were not yet conclusive to warrant definite action.

The hubbub started at home by Mr. Creedy's paper is continued in one of the weeklies (*Electrical Times*) by Messrs. Schoepf and Eborall, who have crossed pens on the knotty problem of the one-phase motor. The latter made some caustic remarks about one-phase motors in general and their American prototypes in particular which were communicated to the discussion of the paper mentioned, and reported verbatim in the weekly aforesaid. Mr. Schoepf, who is the railway motor Hercules of the Westinghouse Company (who are naturally interested in the discussion), mildly disapproves, in his opening remarks, of the supposed pessimism of Mr. Eborall, and then proceeds to flatly contradict the generalisations of the latter on the one-phase motor. His theoretical darts do not appear to get home, but he backs

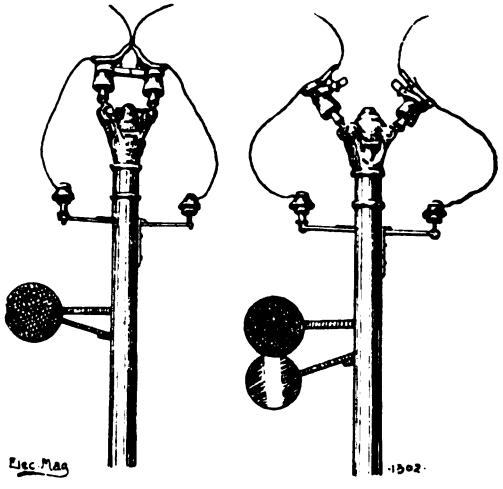


FIG. 3. H.T. SIGNALS AND SWITCHES.

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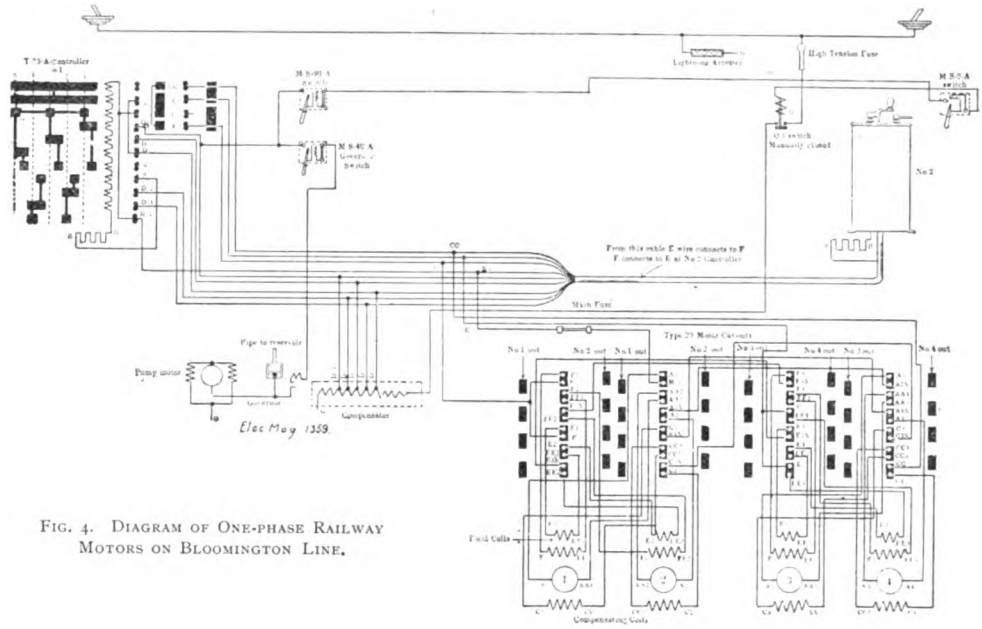


FIG. 4. DIAGRAM OF ONE-PHASE RAILWAY MOTORS ON BLOOMINGTON LINE.

his contradictions by figures which are here given. Mr. Eborall considered that single-phase series motors (generally, of course) were some 25 per cent. larger than direct-current machines of equal capacity. But whatever other motors might be which Mr. Eborall possibly had in mind, the Westinghouse motor was not that much larger, as Mr. Schoepf's figures made to show :—

Capacity in h.p.	Weight of Motor complete.	
	Single-phase series.	Direct-current.
	lbs.	lbs.
50	3,080	3,000
75	3,850	3,840
100	4,523	4,500
150	5,398	5,550

Again, the Westinghouse motor was not of greater length than its direct-current rival, and as evidence figures were also put forward :—

Capacity in h.p.	Dimensions.			
	Single-phase series.		Direct-current.	
	Length.	Min. diam. of wheel.	Length.	Min. diam. of wheel.
	ins.	ins.	ins.	ins.
50	47⅛	33	49⅛	30
75	48½	33	50½	33
100	50⅛	33	51⅛	33
150	51⅛	36	52⅛	33

Mr. Schoepf, however, sticks up for Mr. Lamme's deeds in spite of what may have been said by Mr. Atkinson in 1898 on one-phase motors, and on this score he may confidently escape contradiction by his opponent.

While on the subject of one-phase railway motors, mention may be made of the Bloomington, Pontiac, and Joliet line referred to with great *éclat* in our American contemporaries. The casual reader naturally gets the impression that the track extends the whole ninety miles separating the first and last-mentioned towns. As a matter of fact on digging down into the description he finds that but little over ten miles is so far equipped. He must judge for himself whether this is American bluff or just the ordinary commercial method of stretching a point in the United States. The equipment of the line is, however, very interesting. It may be regarded as the "rival show" of the Indianapolis-Cincinnati road referred to in the March issue. The entire contract is in the hands of the General Electric Company, who are using their compensated one-phase series motor with potential control. A diagram of the connections is shown in Fig. 4, and this will bear careful study. The one solitary car at present doing the service has four 75 h.p. motors each weighing about 4,900 lbs. and operating at 200 volts pressure. The field system, unlike those used on the

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Ballston line, is built up separately and can be slipped into the motor housing. The descriptions refer to this feature as being introduced to admit of easy repair in case of damage to the coils. Opponents of the one-phase motor will probably interpret it as the want of confidence by the makers in the design of the motor. Naturally the manufacturers say they are welcome to their opinion whenever they happen to express it.

The four motors are coupled in series with all the fields on the ground side and energised from the low pressure connections of the compensator. The latter is a 110 kw. oil cool transformer with five voltage taps giving 400, 500, 600, 700, and 800 volts. These points correspond with the five notches on the controller. To prevent arcing at the contact fingers by short circuiting two sections of the compensator, a small resistance is inserted at the moment of passing from one notch to another. Each contact has a separate blow-out, the coils of which are in series. An interesting feature of the equipment is a 25 cycle arc-lamp forming the head light, which so far has given no trouble.

The overhead construction is extremely simple. Two trolley wires with catenary supports are used, both trolley and catenary carrying current. The trolleys are No. 00 grooved copper wire and the catenaries stranded steel cables $\frac{3}{8}$in. diameter, three being seven strands of No. 11 steel wire. Supports are inserted every 100ft., but the matter of reducing these to every 10ft. is under consideration. The poles are 35ft. in length, spaced at 100ft. intervals and fitted with fir brackets 7ft. 9in. in length, supported by knee braces 3in. by 3in. The insulators are supported on malleable iron pins, to which they are attached by Portland cement. At present the line is fed from a temporary plant, and there are no transforming stations, current being fed into the line at 3,000 volts. It is hoped ultimately to equip the entire 90 miles stretch for high voltage one-phase cars, but it is a matter for conjecture whether the present method will be extended over the whole route, though reports state that an additional short length of about five miles is being added.

NEXT MONTH.

Our next issue (July) will be specifically of interest to Traction Engineers.

*Car Wheels—A Study of Their Costs.**

By D. F. CARVER.

(Concluded from p. 434.)

THE steel-tyred and rolled-steel wheels are coming into common use, and a comparison of their costs with cast-iron has some interesting features. As the life of a single steel wheel is equal to several cast-iron ones, it is necessary in making comparisons to accumulate the costs against several cast-iron wheels, as shown in the foregoing table.

That is to say, wheel No. 1 has run 35,000 miles at a net cost of $4.76; wheels Nos. 1 and 2 have together run 70,000 miles at a net cost of $9.99; wheels Nos. 1, 2, and 3 have together run 105,000 miles at a net cost of $15.22; wheels Nos. 1, 2, 3, and 4 have together run 140,000 miles at a net cost of $20.45; wheels Nos. 1, 2, 3, 4, and 5 have together run 175,000 miles, and wheel No. 5 has been pressed off and scrapped at a net cost of $26.16, and

$$\frac{\$26.16}{175} = 14.95 \text{ cents per 1,000 miles.}$$

This progression is shown graphically by line F in Fig. 2.

The cost of a new rolled-steel wheel may be assumed at $20, and it will cost 47 cents to press it on and handle necessary material in connection therewith. At the end of 50,000 miles run its net cost to the company, if it has run, as is perfectly fair to assume it will, is $20.47. Now, if it is taken out of service, turned down, and trued at a cost, say, of $1.50, which is reasonable, and it runs for an additional 40,000 miles, so that its net cost to the company at the end of 90,000 miles run is $21.97, when it is again trued up at an additional cost of $1.50, its net cost to the company when it it worn out at 127,000 miles will be $23.47; but it costs another 48 cents to get it off, and the scrap value approximates $5, so by the time it is scrapped it has cost a total net of $18.94.

$$\frac{18.94}{127} = 14.91 \text{ cents per 1000 miles run,}$$

approximately the cost to run cast-iron wheels. This is a hypothetical case, but it is well within the range of immediate possibilities, and shows what may be expected.

* *Street Railway Journal.*

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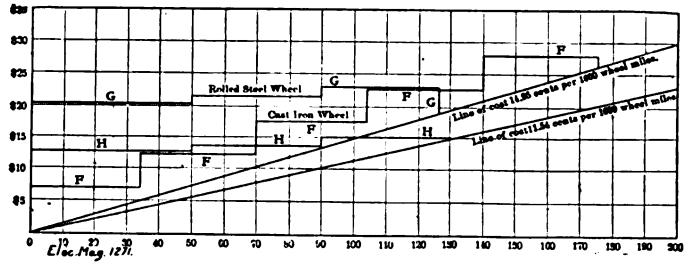


FIG. 2. DIAGRAM FOR COMPARING COST OF IRON AND STEEL WHEELS AND STEEL TYRES.

This progression is shown by line G in Fig. 2. On the face of it, and from superficial consideration only, a 33-in. steel-tyred wheel, at a first cost of $36, with an ultimate scrap value of $6, would have to run more than 200,000 miles to give a service at equal cost with cast iron. But methods have already been devised by which it is not necessary to part with $24 worth of wheel centre and some rim value at a depreciated market value of approximately 80 per cent. There are many cases of a combined city service and suburban service in which it is dangerous to use cast-iron wheels. In fact, it is probable that the steel-tyred wheel may yet enter into strong competition with cast-iron on the basis of cost of wear and tear alone. Line H, Fig. 2, shows the progression of costs of a rim for a steel-tyred wheel at an initial cost per rim of $12 and a net cost to the company after running 130,000 miles of $15, or 11.54 cents per 1000 wheel-miles.

There are three lines along which to work to reduce the cost per 1000 miles, or the wear and tear on car-wheels in city service: One is to increase the latitude of the restriction upon the flange; another, to improve the metal in the flange of present shape, is to make its mileage greater between turnings; and the third is to increase the value to the railway company of the wheel centre, which does not wear out with the rim. Thanks to the efforts of the wheel-makers, many economies have already been given to the railway company by improvements in the latter items.

TABLE SHOWING PROGRESSIVE COSTS OF OBTAINING 175,000 MILES FROM CAST IRON WHEELS.

First cost cast-iron 450lb. wheel, $6·98; scrap value, $2·70; cost of pressing wheel on or off axle, $0·48.

Cost New Wheel.		Cost Labour Pressing on and off, &c.	Scrap Value at 35,000 miles.	Net Cost at End of		Total Cost.
$6·98	..	$0·48	$2·70	35,000 miles.		$4·76
4·76						
6·98	..	0·95	2·70	70,000	,,	9·99
$11·74						
9·99						
6·98	..	0·95	2·70	105,000	,,	15·22
$16·97						
15·22						
6·98	..	0·95	2·70	140,000	,,	20·45
$20·20						
20·45						
6·98	..	0·95	2·70	175,000	,,	25·68
$27·43						
		0·48	..	....		26·16

Electric v. Steam Locomotives.

IN our July and December issues we gave details of the General Electric Company's No. 6,000 electric locomotive, as constructed for the New York Central Railway Company's electrified section. In the December number we published figures obtained during the preliminary trial of this locomotive. From a recent issue of the *Street Railway Journal*, we notice that this electric mammoth has been pitted against a steam rival on the road. The tests were made on April 29th last, in the presence of officials of both companies. A stretch of experimental track six miles in length was used, near Schenectady, for the test, the rails being 80lb. standard section, sixteen yellow pine ties to the 30ft. rail, gravel ballasted, and well-surfaced curves, elevated for a speed of about 70 m.p.h. The weather was quite fine, so that the rails were dry. For 4½ miles the gradients varied from 5ft. to 17ft. per mile, and thence the track descended on gradients varying from 6ft. to 19ft. per mile. In the six miles there were seven curves, varying from 0 deg. 48 min. to 2 deg. 17 min. Power was furnished from a station five miles distant, equipped with a 2,000 kw. three-phase 25-cycle Curtis turbo-generator, supplying 11,000 volts to the line. The adjoining diagram, Fig. 1, indicates the chief dimensions and weights of both locomotives, the weight of the cars, of which there were eight in each case, being approximately 513

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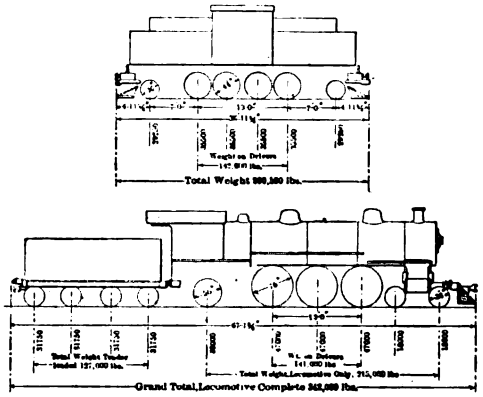


FIG. 1. WEIGHTS AND DIMENSIONS OF STEAM AND ELECTRIC LOCOMOTIVES.

tons. On account of the small feeder cross-section the voltage to the electric locomotive dropped very considerably during acceleration, so that, although it performed well, the results would be greatly improved in actual practice.

In run A both trains started together, the steam locomotive accelerating the faster on account of the voltage drops on the electric locomotive. At 3,000ft. from the start the latter had attained the same speed as the former, and at two miles passed the steam locomotive. In run D a start was made nearer the sub-station to counteract the voltage drop. In this case, the electric locomotive accelerated faster from the outset, and at 1,500ft. from the start was a train length ahead of the steam train. The diagram (Fig. 2) illustrates the acceleration and speedtime curves for this run. From the tests the electric locomotive was proved the superior. It could haul a greater revenue-bearing load of 51.25 tons than the steam locomotive. Its acceleration was .148 miles p.h. per second up to 50 m.p.h., and it required 76 seconds less to attain a speed of 50 m.p.h.

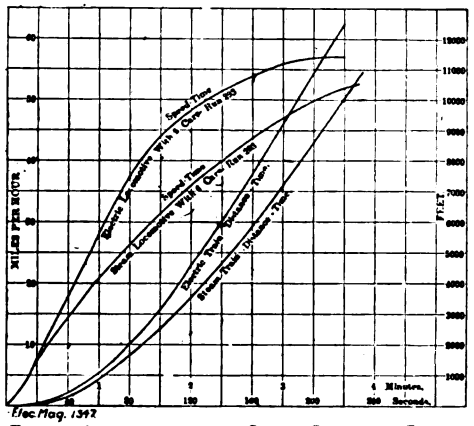


FIG. 2. ACCELERATION AND SPEED CURVES OF STEAM AND ELECTRIC LOCOMOTIVES.

The International Railway Congress.

MORE than ordinary interest for electric railway engineers attaches to the Seventh Convention of the International Railway Congress recently held at Washington. With George Westinghouse as president of the Exposition electric railway matters could be expected to meet with more than cursory treatment at the hands of railway men. The president's remarks on electric traction, in fact, augured well both for the proceedings and the future of the art. "The new era of railway operations has dawned, with its many new problems. I refer to the growing use of electricity for the movement of trains. There have already been such demonstrations of the benefits to be derived from the substitution of the electric motor for the steam locomotive that it requires no great prophet to predict the extensive growth of electric traction upon the great railways of the world, and the eventual replacement of the steam locomotive. Fortunately, the time element, which is such a controller of events, and the financial problems involved, will ensure gradual development and extension of the use of electricity. With these changes have come vastly different engineering problems and new sources of danger, which should, and will, command and receive the attention which is essential to the surmounting of every difficulty as it arose."

The electrical papers presented were four in number, the authors being operating engineers with considerable experience, hailing from Italy, Belgium, France, and America. The papers referred more particularly to work so far accomplished, so that little or no new ground was broken, but it is significant that the subject of electric traction was raised and discussed by a body of steam railway engineers, convened to deliberate on their own particular branch of traction. Great Britain was well represented in the delegates, among whom were Mr. J. A. F. Aspinall, of the Lancashire and Yorkshire Railway, and Mr. A. Wilson, of the North-Eastern Railway. Mr. Aspinall mentioned the Liverpool and Southport electrified line, stating that, though the costs per ton-mile of this stretch were heavier than when operated by steam, a greater milage was run, and the terminal capacity at Liverpool had been doubled by reason of the easy handling of electric trains. The cost of installation was as high as £20,000 per mile. Mr. Wilson stated that in his case steam and electric traction could only be compared with difficulty. With electricity the lines could be better used, and receipts increased thereby. The cost of electric traction on the North-Eastern for February, 1905, reached a total of 2.11d. per power-mile, for a car-mileage of 254,938.

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Readers are referred to the World's Electrical Literature Section at end of Magazine for titles of all important articles of the month relating to Lighting and Heating.

Electric Light Advertising.

By SMILAX.



IN the metropolis and large provincial towns, the average pedestrian cannot do much star gazing. If he frequents the main thoroughfares he will find the celestial bodies eclipsed by glaring sky-signs whose kaleidoscopic variations compel obedient response from his optic nerves. For the man in the street, these changing luminosities have a peculiar fascination, and their physiological effect upon him varies with the character of the commercial articles for which their lamps flash so gaily. He seems to taste the steaming beef-juice, or smell the fragrant fumes, as his eye catches sight of well-known names appearing and disappearing on the sky-line. The electric sign has reached the heights of popularity and advertisers who thus flaunt their wares would not dream of forsaking this eminence from which to attract the public gaze. Although the town dweller may be heartily sick of the vagaries of familiar sky-signs, the last word has yet to be said on this particular form of advertisement. The electric sky-sign leapt into prominence without the aid of a spring-board. It was a good thing, and the man to whom it was useful wanted it badly. The sign-maker has fulfilled his wishes and he has remained content.

On the other side of the Atlantic, "store" keepers get frequent attacks of advertisio-mania which becomes epidemic at night. The accompanying illustrations (kindly supplied by the New York Edison Company through our esteemed contemporary, *The Electrical Review* of that sporadic city), give some idea of the eruptive symptoms which accompany the disease mentioned. It will be seen that no occasion is lost to acquaint the wayward and ignorant of so and so's "store" or such and such a theatre. The New York Edison Company, who obligingly supply current to many thousands of electric signs, containing myriads of lights, appreciate the value of a few pictures of these, enlightening the darkness. They shrewdly guess that Jones of Five-Sixth Avenue is itching to shine down Smith's glare



Photo] *[New York Edison Co.*

BROADWAY, NEW YORK, ON A WET NIGHT.

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Photo] ILLUMINATED SIGNS, NEW YORK AUTOMOBILE SHOW. *[New York Edison Co.*

over the way, and, to stimulate his decision, they send him a photo of Smith's latest blaze. Jones makes up his mind at once, and the supply company enlarge his service to the undoubted eclipse of Smith.

The photographs which illumine these remarks will bear close inspection, though the engraver's art cannot do full justice to the originals. They show what can now be done with the electric sign, and foretell something of its future. For the present, neither its commercial value nor its public importance are appreciated. The average manufacturer can't understand what it means to him. The central-station engineer has yet to realise that the electric sign is worth connecting up despite its bobbing existence. He doesn't even attempt to photograph the

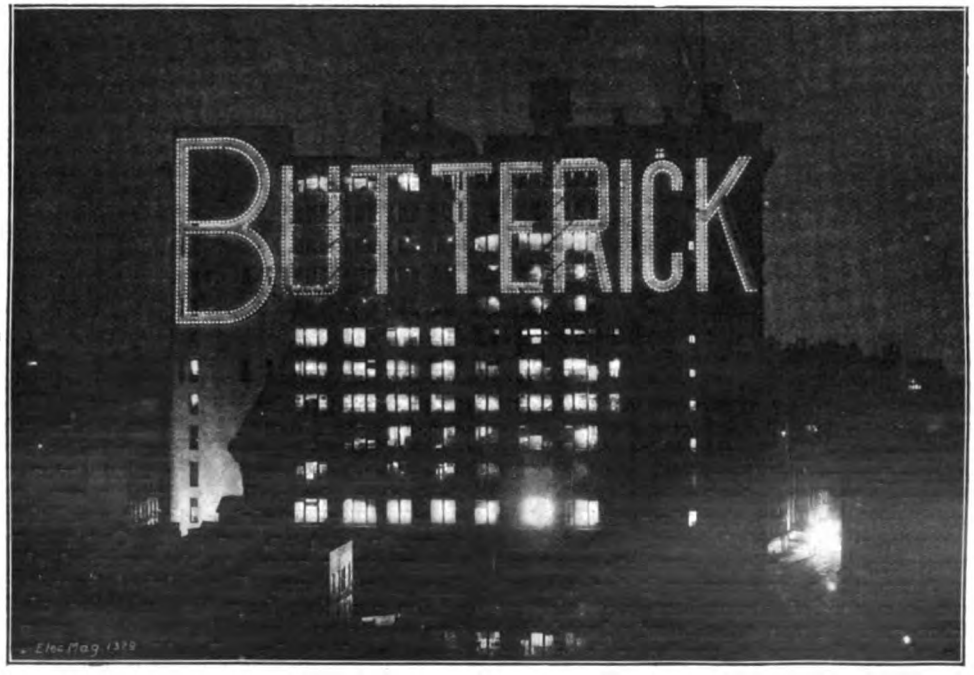


Photo] WILLIAMSBURG BRIDGE ILLUMINATED ON OCCASION OF OPENING. *[New York Edison Co.*

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best sign on his mains, probably because he thinks that the special duty of either the sign maker or user. He is perhaps absorbed with his works costs, but even that pet hobby might be turned to public use. He could write in letters of light over his works or central show-room, if he has one, that "electric juice" was on sale at so much per unit. It is safe to prophesy a largely-increased demand in consequence.

Electric-light advertising is going to do big things if it is given the least chance. It must not, however, be done to death on stereotyped lines. It has got as far as the publicity. It is the largest electric sign in the world, that is, it is the biggest illuminated sign of any sort, because the gas people couldn't crowd 1152 lights into so small a space without the risk of burning the building down. At any rate, if they can they must do something more than tell us so. The eight small letters are 50ft. high and the capital is given the dignity of another 10ft. The lamps are four-candle power supplied at 120 volts, and the energy consumption varies between 17 and 28 k.w. The sign is switched on for five hours each day, being lighted at the close of the busi-



Photo] THE WORLD'S LARGEST ELECTRIC SIGN. *[New York Edison Co.*

talking sign, and in that form has multitudinous uses, but it is a mere chrysalis of its ultimate self. Before it reaches the butterfly stage some co-operation will be needed between the sign maker and the light supplier. Each is essential to the other, and both are necessary to achieve any definite end. What will be the result of their conjoint efforts cannot at the moment be prophesied, but unless they get in double harness "right now" that butterfly will never see the radiant beams of any sign at all.

The illustration on this page shows one of the after effects of an American craving for ness and kept shining till midnight. During the day the lettering shows up dead black on the buff background of the building wall. The proprietors thought that at one time they could illumine this at night by reflected light, but gave up the idea for the incandescent lamps. This is a very fair sample of electric light advertising which might well be copied on this side. The fire-works at the bottom of the opposite page are not electrical in their origin, but the photograph was taken to bring up the illumination of the suspension cables on the occasion of the opening of the new Williamsburg Bridge.

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Rare Earths for Electric Illuminants.

"As scientists and engineers have come to a realisation of the inefficiency of existing methods of illumination, the problem of improving upon these has received considerable attention. While the element carbon has heretofore been exclusively used commercially in both arc and incandescent lights, the rare earth oxides, so called, have recently been found to possess desirable properties for use as illuminants." With these remarks, Mr. M. C. Beebe recently opened an address to the chemical section of the Engineers' Society of Western Philadelphia, on the use of rare earths for electric illuminants. His researches in this province are detailed in the address, and will bear careful study. After reviewing the early work in this field, he takes up the properties of such earths as zirconium, yttria, magnesia, and thoria. He deals especially with the treatment of zircon ore, explaining a simple method for removing iron from it. Experiments showed that the yttria earths of the greatest atomic weights give the most satisfactory results in glowers, but, owing to the great difficulty of separating these from each other, this being possible only by laborious fractionation processes, very little has been done with them. His experiments with glowers in vacuum are very interesting. The vacuum rapidly deteriorates, due to the vaporised metal re-combining with the slight amount of oxygen liberated. This seems to indicate that oxygen forms a part of the conducting circuit, for glowers in hydrogen or nitrogen behave as if in a vacuum, but in carbon monoxide or dioxide they exhibit the same characteristics as in air. Experiments conducted for obtaining self-starting filaments are also of interest. A Nernst glower could be made to conduct current at low temperature by running it for a short time in a rarified atmosphere containing a carbon gas. It was subsequently found that this glower became a conductor in a few minutes. It is uncertain whether the hydrocarbon reduced some of the glower material to its metallic form, or whether a conducting carbide is formed by the action of the gas upon the glower materials. It was found that glowers composed of thoria, magnesia, and almost any refractory oxide could be made conductive by this treatment. A broad field is still open, and there is much yet to learn of the rare metals. Frequently the supposed metal is very impure, and the properties ascribed to it are really those of its carbide or some other little-known combination.

Very little is known of the physical properties of the rare metals. A good example of this is the recently-developed tantalum metal which was not known to be suitable for electric illuminants until quite recently. The tantalum lamp was described and illustrated in this section in No. 2, Vol. III.

On Metallic Arcs.

More or less of mystery has surrounded the development of metallic or flaming arcs. *The Electrical World and Engineer*, commenting editorially upon a recent article which it published on The Metallic Arc, by Mr. I. Ladoff, indicates broadly the principle of such arcs. In the ordinary D. C. arc the light emanates from an incandescent solid body, but much energy is concentrated in a very small space, and the temperature raised to a great extent. The higher the current density, the higher the temperature, and the better efficiency. With the A. C. arc the energy concentration is not so pronounced, and the efficiency falls off in consequence. With the flaming arc the terminals are of materials more volatile than carbon, and furnish a large volume of luminous vapour, that is, of incandescent particles streaming between the poles. The vapour gives the line spectrum of a heated gas, and it is possible to obtain a relatively large amount of radiation as useful light, varying with the spectrum of the section. In the flaming arc the vividly luminous vapour gives a spectrum which, being discontinuous, saves a vast amount of wasted work in the production of radiations useless for illumination. As a result, arcs of great efficiency have been produced, giving two or three c.p. per watt. In Mr. Ladoff's experiments, the oxide in his electrodes has been reduced, and less energy has been needed for breaking up the oxide in the arc, this resulting in increased efficiency. When ferro-titanium is used in either the negative or both electrodes an enormously brilliant arc is produced of a good white colour, more defined than the ordinary flaming arc from more volatile material, and with an efficiency of nearly three c.p. per watt. Our esteemed contemporary points to the practical objections to such arcs. The chief of these is the smoke resulting from the oxidation of the free vapour or from oxide particles thrown off from the electrodes. Considering the great efficiency obtained, it is suggested that considerable trouble might be taken to obviate this difficulty.

The light produced by titanium pencils is agreeable to the eye and pure white in colour. It produces the entire spectrum with special luminosity in the yellow zone. At corresponding current values and voltages the energy consumption per mean spherical candle power is from one-third to one-fourth of that required for carbon electrodes. The best results are obtained when a reflector is used. Under proper conditions the life of the titanium pencil is much greater per inch of material than carbons. With a rutile pencil it is possible to obtain a life as long as that of the present enclosed arc lamp. The luminous efficiency of the ferro-titanium pencil is higher than the rutile, but only slightly so, and for its longer life the latter is to be preferred.

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For titles of all important Telegraph and Telephone articles of the month, see World's Electrical Literature Section at end of Magazine.

Some Problems in the Wireless Transmission of Signals.

(Special Article.)

By L. H. WALTER, M.A., Assoc. M. Inst. C.E., A.M.I.E.E.



IN wireless telegraphy as in most other branches of science, a number of problems of more or less interest, as yet unsolved, present themselves. Some of these may appear unsolvable, others more easy of solution—but in physical science it is not safe to prophesy; those which seem to-day comparatively simple may never be solved, whilst others, at present hopelessly impossible, may perchance be brought within the range of practical realisation by the discovery of to-morrow.

Col. Crompton in his deeply interesting James Forrest Lecture has dealt with several of the problems facing the electrical engineer, and has indicated one of the directions as regards wireless telegraphy, in which advance is to be looked for and is desirable—the production of more continuous trains of electric waves. This problem is of considerable importance, and improvement in this direction will be of value, probably, whatever happens. It is of especial importance in the present state of wireless telegraphy, in which energy is so wastefully applied to effect the desired purpose. In a paper dealing with such a wide range it was naturally impossible to deal otherwise than superficially with the subject of wireless telegraphy. It is for this reason proposed to consider how we stand at present in wireless telegraphy, regarded from the standpoint of the transmission of energy for signals, and not as a mere recapitulation of the possible problems.

The problem set in wireless telegraphy which has been solved is, as is known, the production at a transmitter station of electric waves by the oscillatory discharges of condensers (this being the sole method available at present), which waves are to influence the responding device (coherer, polariter, magnetic detector) at the receiver situated far away. When the distance is increased beyond a certain point, it is necessary either to increase the height of the antennæ or the amount of the transmitter energy, or else to make the receiving device more sensitive. Of these alternatives the former would be the best, since doubling the height gives four times the range; but there is a well recognised limit to the height of both antennæ from practical considerations. The practice has hitherto generally been to adopt the method of increasing the energy supplied to the transmitter, though Professor Fessenden, as an exception, has been consistently working at securing reception with the least amount of energy. Advances have also been made by others, by the adoption of more sensitive detectors; even in this direction, however, there is a fairly definite limit to the advantage to be gained by increase of sensitiveness, since, with potential-operated detectors, this only increases their liability to respond to stray influences. In this connection Captain Ferrié has several times reiterated his view that great sensitiveness is not so very desirable, and he still advocates the use of greater power at the transmitter with a less sensitive detector.

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Considered from the point of energy required, the coherer—the least sensitive of the detectors tested by Professor Fessenden—needs only 4 ergs for a considerable response, whilst the liquid barretter (polariter?) only requires .007 erg. The energy necessary is thus exceedingly small; on the whole there does not seem much room for improvement in this direction even if it were desirable.

Turning now to the transmitter, the one thing that would strike an engineer on first looking into the subject of wireless telegraphy is the waste of power involved—not that there is a large amount of energy employed, but that it has to be used to excite such a large area unproductively. The transmission not being of the ordinary nature, as when a conducting wire is used to determine the direction which the applied energy shall take, obviously differentiates it from other electrical transmissions. An active point is created such that within a circle, of radius determined by the energy used and the height of antennæ, having this point as centre, any receiver with vertical wire of the same height, in any direction, at the same distance away, is subjected to the same p.d., granted that transmission is over water or a homogeneous conducting material. For shipping distress signals this is, of course, of very great value, but for the other commercial uses a distinct disadvantage.

Professor Fleming, in his Cantor Lectures has endeavoured to refute what he calls the general idea that Hertzian wave telegraphy is wasteful, by calling attention to the small amount of energy required to operate a wireless telegraph receiver. This latter fact has already been conceded. He also states that the improvements which have been made in receivers of late years have been so considerable that signals have been received over 3000 miles in 1903, with aerials only one-third longer than employed for 20 miles in 1899 (150ft. and 200ft. aerials respectively). Such a statement tends, however, to give a very erroneous idea as regards the extent of the improvement above mentioned, for about 100 horse-power is used in the signalling to America, as compared with about 120 watts for the 20-mile distance—a ratio of 700 : 1. Since also, by the old Marconi "law," the energy received varies as $1/D^2$, where D = distance between the transmitter and receiver stations, the value of the received energy in the first case, for the same transmitter energy, would only be as $20^2/3000^2 = 1/22500$ of that in the second case. The transmitter energy is, however, 700 times greater, so that the measure of improvement is only about 30; and taking into account the difference in height of the antennæ a further factor $150^4/200^4$, or 3/7, must be introduced, thus reducing the improvement to about 13, a respectable figure, but considerably more modest than the statement of Professor Fleming's would perhaps lead one to expect. As compared with this very considerable advance in receiving arrangements what do we find at the transmitter? An average value of the primary watts for short distances (30 miles over sea) used to be 120 watts (spark length—?) though even now 500 watts are used for 35 miles over land by at least one system. Few figures are available which will allow of the efficiency being deduced, but some measure of this can be inferred from the figures given in Messrs. Duddell and Taylor's recent paper. These authors give, for a 42-foot aerial and 100-200 watts in the primary, the total amount converted into oscillations as being less than 15 watts (as this value includes the ohmic loss)—say 10 per cent. of the total watts. Of this 10 per cent. the maximum amount which could possibly be of avail in affecting the receiver is one half, and it is probably considerably smaller—possibly only that due to a beam of waves included within an angle of 45° on each side of the line joining transmitter and receiver, in which case only one-quarter would be so available. Assuming then—which is by no means the case—that all the 10 per cent. was useful Hertzian radiation, the amount of primary energy which is being usefully applied in the direction of the receiver station is not over 5 per cent. and possibly but little over $2\frac{1}{2}$ per cent. Does it not therefore seem more worth while studying how best to develop the transmitter and the transmitting medium rather than the receiver which, as will be seen from the foregoing, has already arrived at a relatively more advanced stage of development? The extreme devotion to the receiver portion to the detriment of the transmitter is much like what in another sphere an attempt to supply tantalum lamps to lighting plants fitted with Newcomen engines and magneto-electric generators would be.

In attacking the problem of improving the transmitter efficiency, there are several minor features which call for attention; these will

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be dealt with in the second part next month. Of fundamental improvements there appears to be only one at present in the practically realisable sense. This is the polarised wave method of Professor Alessandro Artom. Ever since the announcement was made that a polarised beam of electric waves could be emitted, the possible practical significance of this discovery has been before one; but here again figures have hitherto been lacking on which to base any estimate of the improvements (if any) effected. Still, it has recently been definitely stated that, whereas in the desired direction messages were received at 260 kilometres distance, in a direction at right angles to this the waves were only traceable up to 100 kilometres from the transmitter station. Assuming even that the signals were of the same intensity, which is distinctly unfavourable to the system on the foregoing basis, the energy radiated in the two directions must have been in the ratio $260^2/100^2 = 6.76$ (or taking into account the difference in strength of signals, say 7). Thus seven times as much energy was emitted in the desired direction as in a direction at right angles to this. It is not clear, as yet, whether this can be regarded as a transmission of the nature of, say, (180 + 80) kilometres range in the desired direction and (180 – 80) kilometres range in the other direction, and equivalent to an ordinary (equi-valued radial) transmission over 180 kilometres range for the same transmitter energy. If this be so, the energy required for transmission in a given direction is very considerably reduced by this method, in the ratio $180^2/260^2$ or 81/169, so that, for instance, for transatlantic wireless telegraphy, in place of 100 h.p., only a little over 48½ h.p. would be required. Considered from another and probably more illuminating standpoint, the zone of influence—a point of great importance—in the polarised wave method, instead of being a circle of 6000 miles diameter (assuming all sea) would only be something of the nature of an ellipse whose major and minor axes are 6000 miles and 2300 miles respectively (the transmitter being at the middle point of the axes). What this means is more apparent when the area affected is considered—roughly 28,000,000 square miles, in the case of the circle, and only something under 11,000,000 square miles in the second case. Unless, therefore, quite unexpected losses occur in the polarising of the waves—which is not at all likely—it is probable that to excite such an ellipsoidal area only requires 3·123/9 or 1/2·88 times the energy to effect the reception of messages, which is required by the ordinary wave method; or as applied to transatlantic transmission, only 100/2.88 or 35 h.p., roughly, would be needed, the interference area at the same time being reduced in the same proportion.

(*To be concluded.*)

Making British Telephones.

A Visit to Peel Works, Salford.

THE average user of the telephone does not stop to be patriotic in telephone matters. The name of the maker on his instrument should receive a large amount of observation when making a call, but this does not really come to more than a vacant stare at the name plate. Nevertheless, it is important that Britishers should not only use home telephonic products, but should know where they are made. We were recently afforded an opportunity of inspecting, in conjunction with a party of journalists, the one spot in this country on which telephones are made—the Peel Works of the General Electric Co., Ltd., at Salford. When we say "made," we do not imply the act of putting together or assembling parts imported from foreign climes. In our inspection of the works we actually saw the formation of the atoms, for such they must be termed by reason of their multitude, which go to make up every variety of telephone. During the dispensation of hospitalities, the causes giving rise to our visit were detailed, but as these include a matrimonial compact and correspondence in a contemporary, we can only thus merely refer to them. Of the courtesy of our hosts, who included Mr. Eckstein, one of the directors, Mr. A. Brooker, Mr. A. Trafford, Mr. G. C. Vyle and Mr. P. P. Kipping, all important officials at Peel Works, we can only speak with pleasure, and the ingenuous manner in which they placed the facts of the case before us excluded all thought of formality, and made the tour of inspection all the more pleasurable. The composite page of photographs, which we are able to produce through the courtesy of the Company, tells pictorially the story of the shops visited and their principal products. We will not weary our

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readers by a reiteration of the various departments through which we passed. One thing we may emphasise, and that is that the entire change of processes necessary to the manufacture of telephone and telegraph parts and their assembly into complete instruments is performed throughout at the Peel Works. Modern wood and metal-working machinery deals with the heavier elements, and the departments containing these were an object-lesson of methodical organisation. The programme was so arranged that the manufacture of details and their subsequent assembly were appropriately co-mingled, and the impression of evolution from raw material to finished product was thereby adequately conveyed. The works employ about 1,750 hands, and 1,100 of these devote their energies exclusively to the manufacture of telephones. To keep track of the myriads of parts a special system is in vogue by which the loss of a single item, no matter how small, can be traced. This surveillance was noticeable throughout both the Peel Works and the Victoria Bridge Telephone Stores which we afterwards visited. In fact, by an elaborate but none the less simple card system, output, stock, and sales could be compared both at the works, in the stores, and the branch offices in various parts of the country.

A noticeable feature—in fact, an item which could not well escape observation—was the excellence of the workmanship put into every type of telephone manufactured. The superiority of the finish, which naturally meets the eye and which in some cases disguises a subcutaneous nastiness, was, however, in every instance maintained throughout. Indeed, the high standard of excellence which characterises G.E.C. apparatus was everywhere noticeable at Peel Works.

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Telegraphy Correspondence Class.—V.

Conducted by CICERONE.

To the questions set in exercise III, not so many complete answers have been received from our students as hitherto. It may, therefore, be supposed that the problems have been found a little too difficult for the average competitor, and in future they will be rendered a little easier of solution.

One respected student, who has been most industrious, painstaking, and resourceful in his answers, writes to the effect that such work is entirely new to him, but that he has adopted the plan of sticking rigidly to the formulæ supplied, working every new phase round from the same. That is exactly what he should do, and what is advisable for every earnest worker to attempt. It is a method that will aid the memory, exercise the reasoning powers, and stimulate initiation and resourcefulness. It is not necessary to memorise all specific resistance values and temperature coefficients, but it will always be found useful if one can carry in one's mind the approximate range of such tables, so that he may have some idea as to whether he is near the truth when solving problems. One or two specific values and coefficients might, therefore, be committed to memory in the same way as one carries other useful data.

It is very creditable to find in this student, who, by the way, is situated at a cable station, such capacity for honest work, not only in technical telegraphy, but also in algebra and trigonometry. Let him go on and prosper, and be a sound example to others similarly situated.

There is no doubt that the most difficult and intricate part of technical telegraphy from a student's point of view, is that pertaining to the resistance, length, diameter, and temperature coefficient of conductors. Nevertheless, it is one of the most important points, and should be mastered, although it does involve a little extra strain upon the mind.

The resistance of a copper wire 250 miles in length and 165 mils in diameter has been found from the formula and data supplied by several students, but "Treyar" and "Pelmar" have reached the goal with the least possible circumlocution.

$$R = S\frac{l}{a}$$

where S = specific resistance = .6433 microhm per cubic inch

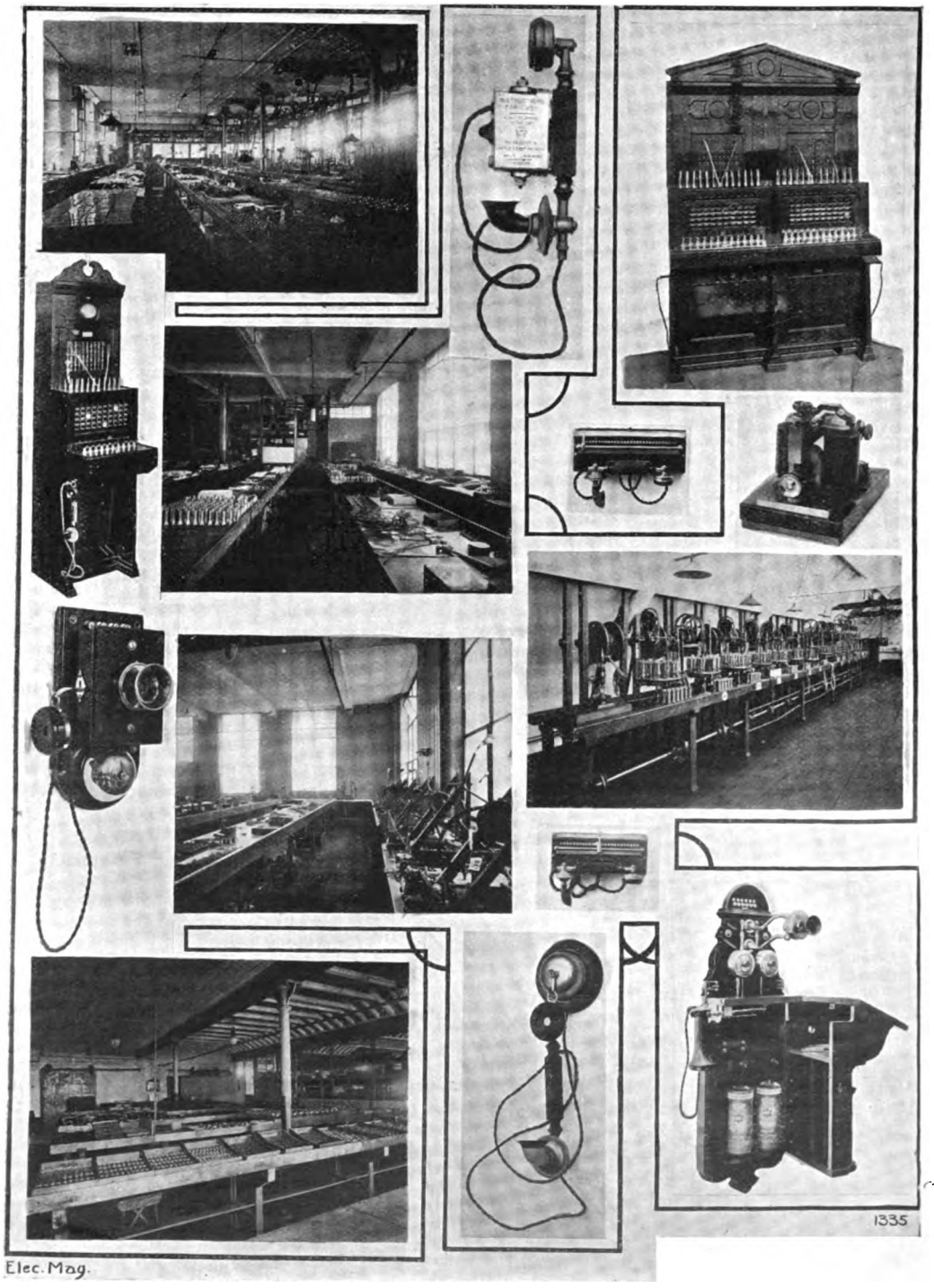
l = length = $250 \times 1760 \times 36$in.

a = area = $\frac{\pi d^2}{4} = \frac{.165 \times .165}{4} \times 3.1416$

$$R = \frac{.6433 \times 1760 \times 36 \times 250}{.165 \times .165 \times .7854} = 476.6 \text{ ohms.}$$

"Pelmar" has worked out the solution to the second half of this question from the formual

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Views of General Electric Co.'s Peel Works, Salford, and their Chief Products in Telephone and Telegraph Apparatus.

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supplied, but "Treyar" has gone a little astray by misconstruing the context.

The increase in resistance due to increase of temperature can always be ascertained from

$$Rt = R_0 (1 + Rt)$$

where

Rt = resistance at temperature given = 20°C.
R_0 = " " zero = 0°C.
t = actual temperature = 20°C.
R = temperature coefficient = .00388

$Rt = 476.6 (1 + .00388 \times 20) = 482.7$ ohms.
Therefore, increase = 482.7 − 476.6 = 6.1 ohms.

The second question was apparently an easy one to most competitors.

The total resistance of ten lamps of 150 ohms each connected in parallel between two wires of 5 ohms, = 150/10 + 5 + 5 = 25 ohms, and the current c in each lamp from 100 volts = C/n or V/r; where V = potential at terminals; r = resistance per lamp; n = number of lamps; C = total current.

$$C = \frac{E}{R} = \frac{100}{25} = 4 \text{ amperes}$$

$$c = \frac{4}{10} = .4 \text{ ampere}$$

$$V = E - v$$

where v = volts lost in leads,

$$v = 10 \times 4 = 40 \text{ volts.}$$

Therefore $V = 100 - 40 = 60$ volts,

and $$c = \frac{V}{r} = \frac{60}{150} = .4 \text{ ampere.}$$

In two parallel wires of 24ft. length and 5oz. weight, and 12 yards length and 2.5oz. weight respectively, the proportion of 30 amperes will be 24.5 and 5.5 amperes nearly.

For similar material, the weight is proportional to mass, and mass = length × area.

$$\therefore \frac{\text{Weight of No. 1}}{\text{Weight of No. 2}} = \frac{\text{length}^1 \times \text{area}^1}{\text{length}^2 \times \text{area}^2}$$

$$\therefore \frac{a^1}{a^2} = \frac{w^1 l^2}{w^2 l^1} = \frac{5 \times 12 \times 3}{2.5 \times 24} = \frac{3}{1}$$

$$\frac{R^1}{R^2} = \frac{l^1 a^2}{l^2 a^1} = \frac{2 \times 1}{2 \times 3} = \frac{2}{9}$$

As the current C divides inversely as resistance:

C in first wire = $\frac{9}{11}$ of 30 amps. = $24\frac{6}{11}$
C in second wire = $\frac{2}{11}$ of 30 amps. = $5\frac{5}{11}$
= $24\frac{6}{11}$ and $5\frac{5}{11}$ amps. respectively.

The second half of this, the third question, was omitted by one or two brilliant students, although it is not so formidable as it looks:

$$R = S\frac{l}{a}$$

$$l = R\frac{a}{s} \quad . \quad . \quad . \quad (1)$$

but $$R = l\,a$$

and $$a = \frac{w}{l} \quad . \quad . \quad . \quad . \quad (2)$$

therefore $$l = \sqrt{R\frac{w}{s}}$$

One foot of copper wire weighing one grain has a resistance of .213 ohm.

$$l = \sqrt{\frac{50 \times 75 \times 112 \times 7000}{.213}} = 117{,}485\text{ft.}$$

The materials best suited for the construction of resistance coils, and for telegraph and telephone lines are well discussed by "Treyar" as follows:—

All alloys have a higher specific resistance than pure metals, and of these manganin is the best suited for resistance coils. It has a higher specific resistance than platinoid, platinum silver, or German silver, and its temperature coefficient is, except in cases of very minute measurement, practically nil. Platinoid and platinum silver are generally utilised for the coils of instruments employed in testing, and German silver for rheostats.

Copper and iron wire are the materials used in the construction of telegraph and telephone wires. Copper has a much lower specific resistance than iron, conducting approximately seven times better. The temperature coefficient of copper approaches half that of iron, and it is non-magnetic, whereas iron becomes magnetised longitudinally when a current flows through it. This property of iron, called its electro-magnetic inertia, is a serious drawback to Wheatstone working, especially on long lines, because the rise and fall of the current are thereby retarded. Copper is the one material used in long-distance telephony and cablegraphy.

"Pelmar," who answers this part of the question very well, has not attempted the second half, as the diameter of the wire was omitted. This omission might have been supplied, or he might have worked it out theoretically, as has been done by another student in this way.

"Let D = outer diameter
d = diameter of core (inner diameter)
l = length of coil
a = diameter of wire to be used
R = radius of outer diameter
r = radius of core.

The number of turns, m, to fill one section depthwise is directly proportional to the diameter of the wire and the available space. The same applies as regards the turns lengthwise, m_1.

The available space depthwise $= \frac{D - d}{2} = R - r$

Available space lengthwise $= l$

therefore $am = R - r$

and $am_1 = l$

therefore $a^2 m m_1 = [R - r]\, l$

Now mm_1 is the total number of turns on the bobbin.

Let $mm_1 = N$

therefore $a^2 N = [R - r]\, l$

and $N = l/a^2\,[R - r]$

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The mean length of each turn $= \frac{[D+d]W}{2} = [R+r]\,W$

The length required $= l/a^2\,[R-r]\,[R+r]\,W$
$= lW/a^2\,[R^2-r^2]$ inches
$= \frac{2\times 3.1416}{a^2} \times [1-\frac{1}{4}]$ in."

Question five (A) has been very satisfactorily answered in the following notes :—

"Weight varies directly as the length and area, the latter being equal to the square of the diameter multiplied by .7854. Resistance varies directly as the length and inversely as the area; it is also proportional to the square of the length divided by the total weight, and, again, proportional to the weight divided by the square of the area, which latter is equivalent to the product of the fourth power of the diameter and $.7854^2$.

In terms of one another :

$$W = L\,d^2\,.7854$$

$$d = \sqrt{\frac{W}{L\,.7854}}$$

$$L = \frac{W}{d^2\,.7854}$$

$$R = \frac{L}{d^2\,.7854}$$

$$= \frac{L^2}{W}$$

$$= \frac{W}{d^2\,.7854^2}"$$

The same student solves the second half of the same question as follows :—

"Let the required resistance $= x$; R is proportional to :

$$\frac{L^2}{W}$$

$$\therefore \quad 100 : \frac{25^2}{8000} :: x : \frac{200^2}{44800}$$

$$\frac{25^2 x}{8000} = \frac{100\times 200^2}{44800}$$

$$x = \frac{100\times 200^2\times 8000}{44800\times 25^2}$$

$$x = 1142\tfrac{6}{7} \text{ ohms."}$$

As showing how the same result may be obtained by a simpler arithmetical method, the subjoined answer is quoted :

"Weight per mile of 1st $= \frac{8000}{25} = 320$lbs.

" " 2nd $= \frac{20\times 112\times 20}{200} = 224$lbs.

With equal lengths, R inversely proportional to weight.

$$\therefore \quad \frac{R^1}{R^2} = \frac{224}{320}$$

$$\therefore \quad R^2 = \frac{320\times 4}{224} = 5.7143 \text{ ohms per mile}$$

$5.7143\times 200 = 1143$ ohms, nearly."

In the next and final question two specimen answers are given, the first being correct and the second slightly wrong. "Treyar" works the first half in this manner :

"Since

$$R = S\frac{l}{a}$$

$$S = R\frac{a}{l}$$

$$\therefore \quad S = \frac{2000\times\left(\frac{50}{10}\right)^2\times .7854}{250\times 1000\times 100} = 1570.8 \text{ microhms per c. cm.}$$

"Pelmar" takes the diameter as 5 instead of 50 millimetres, not a matter of much consequence, and from that standpoint gets this result :

$$S = \frac{l}{Ra}$$

$l = 25{,}000{,}000$ cm.

$a = .5\times .5\times .7854$ sq. cm.

taking diameter as 5 (not 50) millimetres.

$$\therefore \quad S = \frac{2000\times .25\times .7854}{25{,}000{,}000} = 1.5708 \text{ microhms per c. cm.}$$

Finally, in the second half of this question, two answers are quoted, the first being reasoned mathematically, and the second in a simpler way, the results being, though not quite the same, sufficiently near to be of interest to students.

"$R = S\frac{l}{R}$

therefore $a = S\frac{l}{R}$ . . . . . (1)

but $a = d^2\,.7854$.

Substituting this value for a in (1) :

$$d = \sqrt{\frac{Sl}{R\,.7854}}$$

$$\therefore \quad d = \sqrt{\frac{.000000\,6433\times 63{,}360}{5\times .7854}}$$

$$= \sqrt{.0103}$$

$= 100$ mils approx."

In a beautifully simple way another student arrives at this conclusion :

"1 mile at 1 sq. in. area $= .6433\times 36\times 1760$
$= 27{,}893$ microhms.

1 mile at $x^2\times .7854$ sq. in. area $= 5{,}000{,}000$ microhms.

$$\frac{R^1}{R^2} = \frac{l^1 s^2}{l^2 s^1}$$

$$\therefore \quad \frac{5{,}000{,}000}{.27893} = \frac{1\times 1}{1\times x^2\times .7854}$$

$$3{,}927{,}000\,x^2 = 27{,}893$$

$$x^2 = .0071 \text{ in.}$$

$$x = .084 \text{ in. approx.}$$

Answer 84 mils."

As we have now considered the questions of E.M.F and the properties of the conductor, we are at liberty to discuss line construction before proceeding with telegraphic apparatus proper.

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Lines may be overhead, underground, or submarine. Overhead lines have the advantage of being less costly than the other two, and admit of easier access for the discovery and removal of faults, but, on the other hand, they are more liable to break down under stress of weather than either subterranean or submarine lines; more especially than the former.

For overhead lines, suitable wire, insulators, and supports are required.

The wire must have strength, durability, and good conducting property, or, in other words, low resistance.

Iron is comparatively cheap, and is strong except when chemically attacked. It can also be made durable by care in manufacture and good galvanising. It has a high resistance, however, and in consequence of having to increase its diameter on this account its electrostatic capacity is increased, as well as its weight. It also possesses electro-magnetic inertia.

Copper is dearer than iron, but can be made quite as strong, and is proof against chemical attack. It conducts about six and a-half times better than iron, and has commensurately less electrostatic capacity and has no magnetic inertia. Aluminium is also dear, and is not quite so strong, but is immune from oxidisation. It has about the same resistance as copper, weight for weight, but is so light that it becomes bulky. Its electrostatic capacity is, therefore, considerable; there has been some difficulty in making a reliable joint.

Bronze has great tensile strength, but its resistance is so high that it can only be used on short lines advantageously.

Copper and iron may therefore be said to be the chief metals used in the manufacture of telegraph wire for lines.

Iron wires are made of the finest Swedish soft iron. During manufacture they undergo the following processes: (1) puddled in a furnace; (2) hammered into a compact form; (3) rolled between rollers into a long thin bar; (4) milled in the rolling mill into circular form of required diameter; (5) drawn through a series of dies which hardens and stretches the material; (6) annealed, to soften, and make pliable; (7) cleaned in hydrochloric acid; (8) galvanised by drawing through a tank of molten zinc; (9) scraped smooth in sand.

In Germany and some other countries the wire is finally drawn, while red hot, through a linseed oil-bath, a process which gives it a protecting coat of varnish.

Copper is treated somewhat similarly—except the galvanising—but the greatest possible care must be taken to protect the molten copper from currents of air; and all traces of arsenic and other foreign ingredients must be carefully expelled.

Severe mechanical tests are applied to the wire before it is placed on the market for the purpose of determining its tensile torsion and ductile strength.

The function of an insulator is to insulate, isolate, or confine the electric current to the environment of the conductor. That is a rough-and-ready definition that will perhaps suit the purpose here, although not scientifically accurate.

There is no absolute insulator of the electric current. Every material conducts it more or less. Materials offering the minimum resistance are called conductors; those offering a maximum resistance being called insulators. It is all a question of degree. The best conductors are the pure metals.

An insulator being the converse of a conductor, it becomes necessary to select for the best insulator the worst conductor. Then the same laws inversely apply as in the case of conductors. The longer the path the greater the resistance, and the less the insulating property; the broader the path, the less the resistance and the less the insulating property.

(*To be continued next month.*)

EXERCISE V.—JUNE, 1905.

1. (*a*) Discuss the relative advantages of copper, iron, aluminium, and bronze for overhead wires.

(*b*) To what tests is copper wire subjected in order to determine its quality?

2. (*a*) What is the breaking strain in hundredweights of a red pine pole, the length from the ground line and diameter of which are 20ft. and 10in. respectively?

(*b*) How much would the value of the strain be altered if a 10in. square beam of the same length and class of wood were substituted: the coefficient of rupture for red pine being 7?

3. (*a*) Describe some good methods of preserving a telegraph pole from decay.

(*b*) What is the best form, and most suitable material for an insulator on an overhead telegraph line?

4. (*a*) Describe briefly how iron or copper wire is manufactured?

(*b*) What special precautions are necessary to guard against electrical and mechanical flaws?

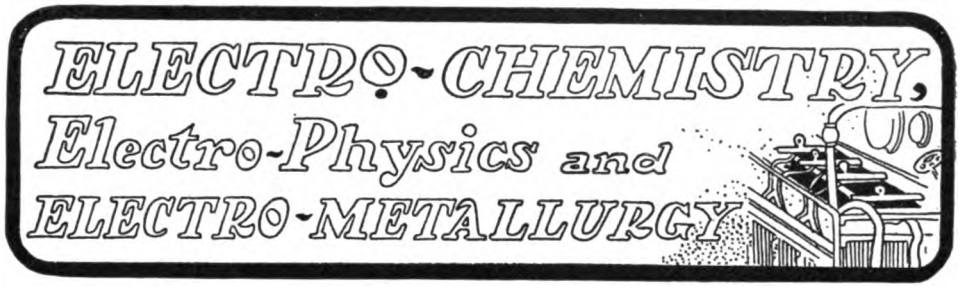
5. (*a*) What is the breaking strain of a wire 200 mils in diameter if the specification quotes 25 tons per square inch of sectional area?

(*b*) Calculate the strain on a terminal pole carrying twenty wires, each exerting a pressure of 170lbs., if the pole measures 22ft. from the ground line to the resultant point?

6. (*a*) A specimen insulator has a resistance of two and a half megohms. What is the insulation resistance of a theoretically perfect telegraph line 222 miles in length and having 25 poles per mile?

(*b*) The total insulation resistance of a line is 5,000 ohms. What is the resistance per insulator if the line is 300 miles long and the poles 20 yards apart?

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Titles to all important articles on the subjects covered by this section will be found in the World's Electrical Literature Section at end of Magazine.

The N-Ray Mystery.

(Special Article.)

By J. GARCIN.

(Continued from p 453.)

IN the last issue of this magazine the writer dwelt briefly on the origin and nature of N-rays, and gave a short historical sketch of their discovery and the controversy which has been continuing ever since. Before devoting himself to an exposition of the principal properties of N-rays, which is the purpose of this article, he will do well to warn his readers that the following statements are abstracted from various reports on phenomena observed by N-ray experimenters in the course of delicate and difficult experiments. Most of these observations, therefore, need checking and controlling before receiving the full sanction of science; but if all the writer's statements were headed by the words, "It is believed that," or "Professor So-and-so says," this short serial would develop into a very dull and prosy compilation. Turning now to a rapid enumeration of the principal sources of N-rays, it may be said, roughly speaking, that these are of two kinds, the luminous, and the non-luminous. Amongst the former, the sun, of course, takes the first place, and a very simple experiment confirms this fact. The windows of a sun-exposed room should be closed with wooden shutters, or, failing this, blocked up with panels so as to obtrude all light. If now one of the test methods which will be described later be applied, it will be found that the N-rays emitted by the sun are pouring into the room through the wooden panels. Another powerful source of N-rays is a Nernst lamp. As is well known, the filament of this lamp is made up of oxides of the rare metals, which are heated to incandescence by passing an electric current. The rays appear to proceed from this filament, and their emission is so abundant that Blondlot employed this source when experimenting on the dispersion of N-rays with a view to determining their wave-length. Crookes' focus tube, though a much feebler and less convenient source to operate with, deserves some mention from the fact that it was the first source discovered by Blondlot, and some details may be given on the manner in which he conducted this first experiment. A focus tube is connected to an induction coil by wires BH, B'H' (Fig. 1), covered with gutta-percha. Two other wires, covered with the same material, AI*c* and A'I*c'*, terminate at A and A' in two loops, which surround BH and B'H' respectively; a bit of glass tubing, not shown in the figure, keeps each loop separate from the wire which it surrounds. The wires AI, A'I' are then twisted together, and their sharply-pointed ends, *c* and *c'*, are fixed opposite each other at a very small distance, adjustable at will, so as to form a small spark-gap. By this arrangement the electrostatic influence

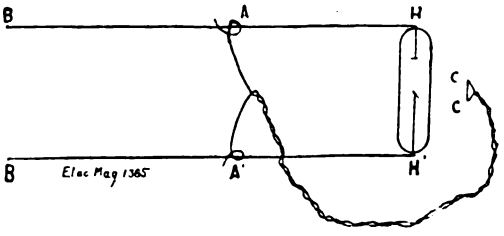


FIG. 1.

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exercised by wires BH and B'H' on the loops A and A' produces at each break of the current in the coil a small spark at the gap *cc'*. Owing to the flexibility of the wires, the straight line *cc'*, along which the spark occurs, can be set in any direction. A sheet of aluminium foil 40cm. square, is interposed between the tube and the spark, so as to prevent any direct influence of the electrodes of the tube on *cc'*. With this arrangement Blondlot experimented on what he considered was the polarisation of X-rays, but he subsequently discovered that the rays under study were not Röntgen rays, since they underwent refraction and reflection, which properties X-rays were known not to possess. By altering the azimuth of this little spark, *i.e.*, by turning it first parallel and then perpendicular to the focus tube, he found that the spark exhibited marked changes in brightness in passing from the first position to the second. This fact showed that the pencil of unknown radiations he was studying presented the same assymmetry as a pencil of polarised light. According to Newton's definition, it had sides differing from each other; in other words, it was polarised in the complete sense of the term.

Amongst other luminous sources may be classed Auer burners, sheets of metal heated to redness, gas flames, &c.

Turning now to the non-luminous sources, we find that Blondlot's researches in this direction were suggested by certain experiments of a very interesting nature conducted by M. Charpentier on the tissues of living muscles. These experiments led Blondlot to suspect that certain bodies could acquire the property of emitting N-rays by mechanical compression. To ascertain this he compressed, by means of a carpenter's press, bits of wood, glass, rubber, &c., and was able to observe that these bodies had in fact become, during the compression, sources of N-rays. Subsequent researches showed that bodies in a permanent state of internal strain possessed the same property. To produce N-rays therefore, there is no need for complicated apparatus. Steel nibs, bent walking sticks, pocket-knife blades, and many familiar articles of everyday use, may be used as sources; and the writer would here point out that would-be searchers have every opportunity of exercising their ingenuity, and constructing experiments of the most elaborate kind, with the simplest and roughest appliances.

If bodies in a state of strain enjoy the property of emitting N-rays, then such a property must also be conferred on bodies in a state of vibration. This argument is confirmed by M. Macé de Lépinay's experiments, which showed that tuning-forks, bronze bells, steel cylinders, stretched wires, were all sources of N-rays as long as they were kept in a state of vibration; the air conducting the sound-waves becomes itself a source. Here then we have another store of N-rays. Such simple auditory phenomena as laughing, clapping one's hands, whistling, &c., produce the same rays which are emitted by a Crookes focus tube.

Amongst other non-luminous sources which are less easy to handle may be named magnetic fields, Hertzian oscillations, liquefied gases, odoriferous substances, soluble ferments, vegetable tissues, &c. One source deserves special mention—the human body. On the 14th of December, 1903, Professor Charpentier sent in a communication to the Académie, stating that living tissues are capable of emitting N-rays. The eminent professor had probably no intention of asserting that in addition to the calorific radiations emitted by the human body, others existed which were of a more or less ethereal kind, defying ordinary scientific analysis. Ideas of this kind are as old as the hills, and have sprung up periodically more than once or twice in every century. M. Charpentier's statements were simply to the effect that muscular and nervous tissues were permanent sources of N-rays, the intensity of emission being the greater as the muscle is more contracted or the nerve more completely fulfils its function. A superficial nerve may be localised and traced by the observation of the N-rays which it gives forth.

The foregoing paragraphs deal with the primary or original sources of N-rays. In addition to these quite a host of secondary sources exist; these are bodies which have been subjected some time to the action of N-rays, and having absorbed them or stored them up internally, are able to radiate them after the source is removed in the same way as light or heat is absorbed and radiated by certain bodies. This property of absorbing N-rays was discovered by Blondlot in the following manner: In one of his researches he concentrated the N-rays proceeding from an Auer burner by means of a quartz lens. Having removed the

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source, he found that the emission still continued, and took some considerable time before subsiding. This fact was traced to the absorption of N-rays by quartz. Further trials showed that pebbles, calcareous stones, bricks, dilute salt solutions, and the liquid media of the eye, were all N-ray absorption bodies. Sea-water stores up N-rays, and this and other phenomena of induced activity may possibly have some hitherto undetected influence on certain phenomena of animal and vegetable life. Iceland spar, fluor-spar, barytine, glass, &c., behave like quartz in this respect. The filament of a Nernst lamp remains active several hours after it has ceased to emit light. Aluminium, wood, paper, whether wet or dry, paraffin, do not possess the property of storing up N-rays. Calcium sulphide, a substance whose name will occur repeatedly in this article (for its luminosity is made use of to detect the presence of N-rays) presents this induced radio-activity.

The storing up of N-rays by the media of the eye affords an explanation of the appreciable time interval which occurs before the observation of the effects of these radiations. Another very active accumulator of N-rays is sodium hyposulphide, whether solid or dissolved.

The next question is: What are our actual means for detecting the presence of N-rays and studying their properties? The first agent (chronologically speaking) employed for this purpose is the electric spark. This should be very small and faint, otherwise the increase in glow which one should observe when N-rays are impinging on the spark becomes too small in relative value to be perceptible; and, further, it is impossible to obtain a large spark having a steady and regular brightness when in the normal state. When the observer has noted the increase in luminosity due to the action of N-rays, if then the source is removed, or the N-rays are intercepted by a lead screen or another substance opaque for such radiations, this increase in brightness should disappear, and the spark resume its normal glow. A pane of ground glass placed just in front of the spark, so that its glow is manifested by a small luminous patch on the glass, will be found very useful for noting the increase in brilliancy, for when N-rays are present the patch will broaden and its contours will stand out more sharply. Any small steady flame will behave in the same manner as the spark in regard to N-rays. If a blue flame be used just about 1mm. long, this should be seen to whiten and become distinctly more luminous when N-rays are applied. The action of N-rays on a small flame led Blondlot to infer that they would exercise a similar action on solid incandescent bodies. To ascertain this, a platinum wire about one-tenth of a millimetre in diameter and 15mm. long, was heated to a dull red by an electric current. A pencil of N-rays emitted by an Auer burner, was directed through wood and aluminium screens on this wire, and was concentrated by a quartz lens. The wire was observed through a plate of ground glass, fixed to the same support as the wire itself, and about 3cm. in front of it. On displacing the wire, several foci were found. Blondlot generalised these experiments by employing, instead of a wire heated by an electric current, a sheet of platinum, 0.1mm thick, inclined at 45° on the horizontal plane, partially heated to a dull red by a small gas-flame placed underneath. A horizontal pencil of N-rays, concentrated by a lens, was made to impinge on the under face of the sheet so as to produce a focus at the heated spot; on the upper face the incandescent patch was observed without interposing ground glass. The variations in brightness are exactly analogous to those of the wire. Another most useful and convenient agent which is most extensively employed is phosphorescent calcium sulphide. N-rays are incapable of producing phosphorescence in the same way as ordinary light, but when a body like calcium sulphide has been previously rendered phosphorescent by sun-exposure, for instance, the rays have the property of notably increasing its phosphorescent glow. This property of N-rays is analagous to that of red and infra-red rays discovered by Ed. Becquerel, and may be also compared to the action of heat. Nevertheless, it has been found impossible to prove that N-rays have the power of rapidly exhausting the phosphorescent capacity in a body as in the case of heat. Almost all experimenters use sulphide screens, but the methods recommended for using this substance are very varied. Blondlot makes use of powdered calcium sulphide mixed with collodion, diluted with ether, so as to form a very thin paste; drops of this paste are painted on blackened cardboard with a water-colour brush, so as to produce small patches several millimetres in diameter, close

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to each other. The screen then presents the aspect of a spotted fabric. If, after being exposed to light, it is examined in a dark room, and in perfect silence, some of the spots will appear less luminous than the others. Usually, some will not seem to be sharply separated from their neighbours, but will form a sort of confused nebula, less visible than the rest. Now, if one speaks aloud or whistles, or if a knife or slightly-bent stick or the clenched fist, &c., be brought near to the cardboard, all the spots will become distinct and more luminous; the nebula resolves itself. When the rays are suppressed, the screen resumes its former aspect. In the following chapter, a brief enumeration of the methods proposed by other experimenters will be given.

[*We have obtained a number of fluorescent screens for our readers to conduct their own experiments, and shall be pleased to supply them at the price of 7d. post free. Interested readers are also referred to the review section this month for notice of a work on N-rays.*]

THE AMERICAN ELECTRO-CHEMICAL SOCIETY.

Pressure on our space crowded out of our last ssue reference to the seventh general meeting of the American Electro-Chemical Society, which transpired on April 25th and two following days. The history and work of the Society stamp its deliberations with the mark of value, and its seventh session must rank ahead of its predecessors on the score of theoretical and practical interest. A feature of the meetings was the attention given to the subject of electrolysis. Dr. Carhart's presidential address was replete with historical references to the work of Grotthus, Clausius, and Arrhenius, not forgetting the valuable work of Davy, Faraday, and others. He said that the dissociation theory of Arrhenius should be given credit for much good, but yet regarded as a working theory until replaced by one more satisfactory and more generally applicable.

The lengthy reports of the meetings, filling several pages of our two important American contemporaries (from which we cull a few particulars), treat fully of the principal papers and discussions thereon. The narrow limits of our space, however, only admit of brief reference to a few of these. In the discussion on conduction in electrolytes it transpired that electrolytic action takes place to a small extent in a Nernst glower. The air surrounding the glower becomes ionised and conducts to a certain extent. The effect can be demonstrated by fitting a glower with one platinum and one silver electrode. Some interesting work was described on the recovery of lead from the peroxide of lead of lead storage batteries. A mixture of peroxide of lead, chloride of sodium, sulphuric acid, and water was electrolysed between horizontal planes. The mixture stratified, the upper layer being spongy lead, the second lead sub-oxide, the next litharge, the next lead-sulphate, then lead-chloride, and finally lead-peroxide. The rate of reduction was one ton for 435 kw. hours, which, at the rate of £3 5s. per kilowatt-year gives a cost of power for extracting one short ton of lead as 3s. 2d. The subject of reducing titaniferous ores produced some interesting figures. A small electric furnace was used, containing 4.4lbs. of ore per charge. From samples of the ore, the percentage of pure iron recovered was from 97½ to 98½. The slag of ferro-titanium is very rich in titanium, which can be profitably extracted. Five minutes is needed to heat the charge, and three minutes for the reduction, the energy for the whole time being about 11.25 kw. The reduction of a ton of ore is estimated at about £4, but nearly half of this is recoverable in by-products. Among the latter is ferro-titanium, which is very suitable for rail-road car wheels, it having better wearing properties than any other steel; titanium carbide is another by-product, much harder than carborundum and commercially valuable as an abrasive. Other valuable by-products are the mordants and pigments of titanium, and also the silicide, the boride, and the nitride of titanium, which are excessively hard and can be used for polishing diamonds. A further interesting subject was an electrostatic method for separating and concentrating ores. This process relies on the repulsive action exerted between electrically charged bodies and on the fact that good conductors are more quickly charged than poor ones. With the method employed the ore must be reduced by grinding, and it is then allowed to fall on a charged revolving cylinder. The conducting particles are thrown off at an angle while the non-conducting particles drop perpendicularly. A number of these machines have been used in the Western States of America for two years with considerable success. With copper ore containing 4.6 per cent. copper, the heads, after concentration, contained about 34 per cent. of copper and the tailings less than 1 per cent. The process has been applied with various ores with complete success, and also for purifying graphite. The production of silicon in the electric furnace was also dealt with, and its possibilities as a resistance material in a granulated form specially emphasised. For example, by applying pressure, the resistance can be varied from 300 or 500 to 1, the original high resistance being obtained by shaking the material. Fusion takes place at too high current densities, but this can be avoided by water cooling. The material has a resistance two or three times as great as that of carbon. Reference is made in the Editorial Notes to other important papers.

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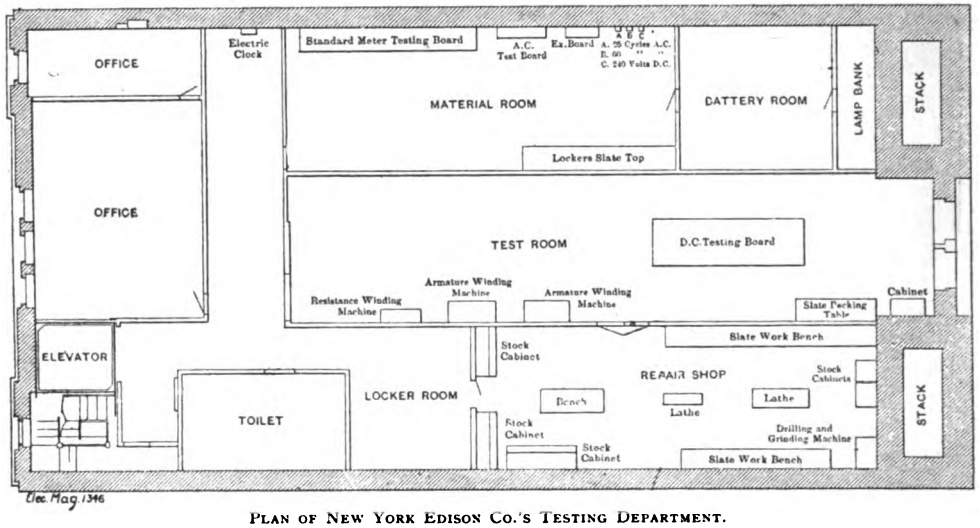
The World's Electrical Literature Section at end of Magazine contains a classified list of all articles of interest to Central Station men. Consult it and save yourself much valuable time.

Meter Matters Generally.



IF some inventive genius could bring out a lamp which would burn for a definite number of hours and no longer, central station engineers and their customers would not be worried with meters. The latter especially regard these devices as the one great drawback to the use of electric light. In this country we have practically abolished the old flat lamp rate. In America, although meters are now more commonly used, quite a quantity of customers take as much current as they can get, and pay a fixed price per lamp per annum. Improvements in meters and activity of the sales agents of their makers, however, are doubtless responsible for the increase in their number on supply circuits. It is consequently not surprising to find meter matters discussed before the American Institute, or to see articles on the subject in the technical press "on the other side." An enormous undertaking like the New York Edison Company naturally has an extensive meter department. This was recently described in *The Electrical World and Engineer*, and from our contemporarys we reproduce a plan of it. The room shown is on the top floor of the old 39th Street Station and measures 50ft. by 100ft. This elevated position probably accounts for the great number of flexible suspensions and air cushions used. The equipment includes a large number of testing boards, a bank of 1,000 lamps, and a 140-cell 250-volt battery. This is connected up for three-wire working, and when testing D. C. meters one side is used for potential excitation and the other for the current demand. A feature is a checking clock connected to a relay and sounder giving beats of standard seconds. By this all the staff watches are set once a day. Two methods of testing are employed, one by an ammeter and voltmeter, and the second by a rotating standard. The latter is of the multiple field coil type, and is carefully checked each day before testing commences, this being done at the company's laboratory in 26th Street. Both the ammeter and voltmeter are Weston Standard instruments, specially iron clad for protection from stray fields. Alternate current meters, which are in service in the boroughs of the Bronx and Manhattan, are also tested, current being supplied at sixty and twenty-five periods. The same department includes a repair shop for armatures, shunts, resistances, fields, &c. Magnets are also checked by special testing machines, comprising two copper discs mounted on a common shaft. Spanning the edge of one of the discs is a magnet of standard value mounted to swing upon knife-edges, a constant counter weight serving for determining the proper speed at which the magnet swings free due to the eddy-current effect. A sliding counter weight on a graduated arm denotes the relative strength of the magnet spanning the other disc. Life tests of sapphire ball bearings and flat and cupped diamonds for meter bearings have been conducted for several years. Diamonds have been found very satisfactory, and 15,000 are now in use on the Company's circuits.

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PLAN OF NEW YORK EDISON CO.'S TESTING DEPARTMENT.

The same building also includes a meter stores with a complete stock of 5,000 meters. These are numbered on receipt, and the highest serial up to March 1st, 1905, was 54,890, all of which are Thompson recording wattmeters. The size of a customer's meter is fixed by the contract and inspection department. The distribution department fixes the meters notifying the auditing department of the withdrawal from stock, the contract and inspection department being notified of the installation. The meter department is then promptly advised and can inspect the meter within one week of its fixing. Test cards are made and filed and can be constantly referred to. During 1904, 56,515 D.C. meters were tested, these ranging from 3-amp. size to the 3000-amp. size. Of these tests 34,909 were periodic tests. About sixty men are engaged in the department, and the records show that the average meter installed was inspected at least twice a year.

From the same American contemporary we take a few remarks by Mr. A. E. Walden on Meter Testings for Small Stations. We can give his principal suggestions in his own words. "A convenient method for obtaining loads having power factors as low as 50 per cent. is found in the employment of choke coils such as are used in alternating-current arc lamps designed for constant-potential mains. A bank of five or six of these coils, arranged for series or parallel grouping, will prove sufficient for the small station, having from 400 to 1,200 meters.

For general testing purposes it is economical to use a single standard 5-amp. meter in combination with current transformers when larger capacities are required.

For the testing department of a small central station, the following instruments will be required: An indicating wattmeter, 0 to 500 watts, 110 volts; an indicating wattmeter, 0 to 2,000 watts, 110 volts; a voltmeter, 0 to 250 volts, with special point at 110 volts; a portable ammeter, 0 to 25 amp., and a stop watch, which should be checked frequently with government standards."

Before the American Institute of Electrical Engineers, Mr. W. J. Mowbray recently dealt with the maintenance of meters. He referred to a portable test meter for quickly and accurately ascertaining the percentage, by which a meter is running fast or slow. This is similar to an ordinary watt hour motor meter with a rotating armature whose revolutions represent the passage of a certain number of watt hours. The ampere capacity of this meter can be varied at will by means of a plurality of windings. The test meter can be stopped and started as desired, and is only allowed to rotate while the meter tested makes one or ten revolutions. A comparison of the watt hours corresponding to the latter revolutions with the true watt hours as recorded by the test meter shows instantly whether the rate is fast, slow, or correct. The cupped diamond bearing, which is now a commercial product of the improved lapidary art was practically the

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acme of perfection as a meter bearing, the initial friction being a minimum and the wearing qualities a maximum. Before the same Institution Mr. J. D. Nies dealt with the defects of poly phase meters. Errors with instrument transformers were due to local impedence of the pressure transformer and magnetising current in the current transformer. The secondary E.M.F. of a potential transformer has a lower value than that obtained from the ratio of transformation, this varying with the load and its power factor. The best that could be done was to make the ratio correct at half load. With series transformers the current was too small, and there was a phase difference between primary and secondary currents. Both transformers produced an alteration in the apparent phase of the current in the direction of lead. Consequently a lagging current registered in the meter with a reduced angle of lag and a leading current with an increased angle of lead. Considering induction meters for measuring poly-phase power, one single-phase meter was only accurate with balanced loads. The two meter method while theoretically correct had practical disadvantages with average low power factor. A better method was the mechanical combination of the two moving elements, though this increased the difficulty of calibration. The best plan would be to use three separate one-phase meters with pressure coils star connected and the junction point coupled to the neutral of a star connection of the secondaries of the pressure transformers.

At the same meeting Mr. F. P. Cox dealt with the use of instruments on switchboards. On railway circuits, considerable overload should be allowed for, and light load errors could be ignored. The opposite is the case with instruments for lighting circuits. Integrating instruments should be fully loaded under normal conditions, as they have an inherent overload capacity not possessed by indicating instruments. The safety afforded to operators by current and potential transformers more than compensated for the slight errors which these introduced. In the discussion it transpired that in Massachusets, where a law provides that a customer complaining of his meter can have it tested free of cost the amount of money refunded in 1904 was $4.5. In the same State, and for the same period 14 per cent. of the electricity meters were found to be fast. One of the speakers, referring to sapphire bearing jewels, said that in a certain lot of 3-phase meters equipped with them registration was never within 10 per cent. of accuracy.

Feeder Relays.

THE subject of automatic relays is always interesting despite its complicated aspect in practice. Feeder relays, however, are called for by sub-station practice, and the methods of their application here outlined are taken from a paper recently presented to the American Institute of Electrical Engineers by Mr. G. F. Chellis:—

"The method of protecting feeders depends upon the operating conditions. This subject may be most consistently discussed by considering the conditions from the power-house alternating-current bus bar to the sub-station direct-current bus bar. To guard against overload, and to open the circuit in the event of a short-circuit a relay is required at the power-house end of each feeder. A relay is also required at the sub-station end, where the feeders are operated in parallel, being connected to a common sub-station bus bar, or where the sub-station bus bar is divided, leaving groups of two or more feeders in parallel. This can be seen by considering the diagram, Fig. 1, in which four feeders, *a*, *b*, *c*, *d*, are shown in parallel, and four converters connected to the sub-station alternating-current bus bar and feeding the direct-current bus bar. Should a short-circuit occur at the point *x* on *b* feeder there would be a rush of current from the power-house bus bar, and also from the sub-station bus bar to the point *x*. In *a*, *c*, and *d* the current would be increased, due to the short-circuit being fed by these feeders through the sub-station bus bar.

"Since a synchronous converter generates an alternating-current E.M.F. corresponding to rated pressure at synchronous speed, in case the point *x* is near the power-house it is possible that the direction of the flow of energy in feeders *a*, *c*, and *d* would be reversed, due to the synchronous converters feeding the short-circuit back through the power-house bus bar, as well as directly over the short-circuited feeder.

"Because of the great amount of energy stored in the synchronous converters, it is also possible for all the sub-stations to feed

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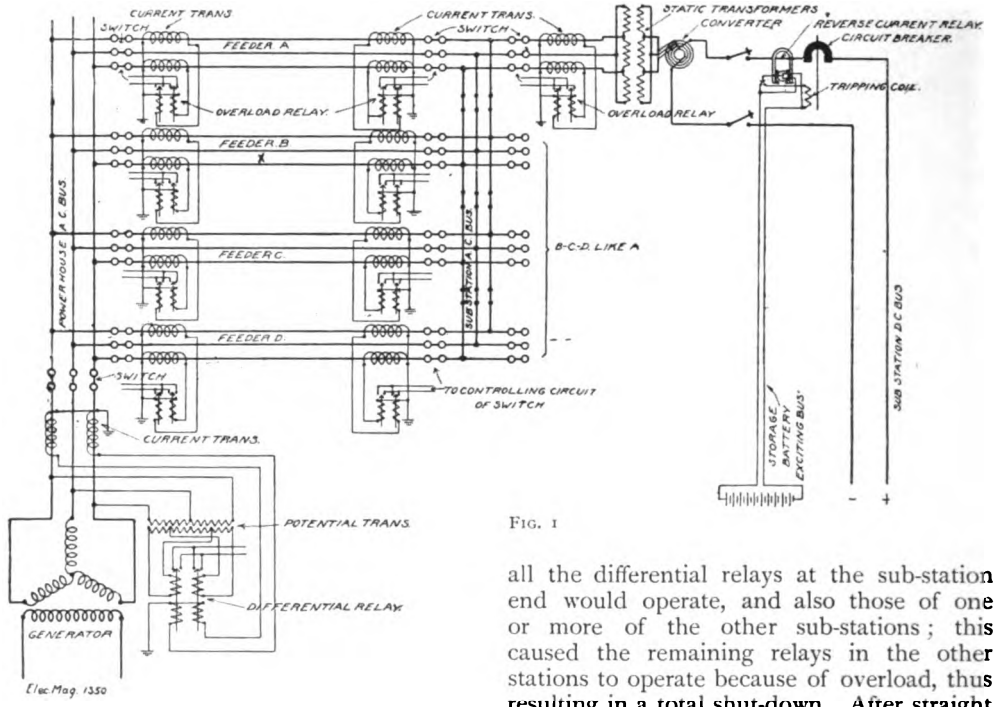


FIG. 1

back into a short circuit in this manner. To fulfil requirements properly, an ideal combination would be an overload time-limit relay at the power-house end and an instantaneous reverse-current relay at the sub-station end of each feeder. The writer does not know of an alternating-current reverse-current relay, the operation of which does not depend upon the pressure of the system, nor a relay that depends upon the pressure operating on a reversal only, that would not become completely inoperative at zero pressures or at comparatively low pressures. If differential relays were used, with a "differential factor" sufficiently high to render the relays of any appreciable value at low pressures, it is probable that they would be so sensitive that any disturbance causing a momentary reversal, without a serious decrease in pressure, would cut the station out unnecessarily.

"This theory is borne out by the experience of the Interborough Rapid Transit Company in the sub-stations of the Manhattan division, where instantaneous differential relays were installed at the sub-station end of the feeders. When feeders were operated in parallel, it was found in most all cases where a feeder became short circuited that all the differential relays at the sub-station end would operate, and also those of one or more of the other sub-stations; this caused the remaining relays in the other stations to operate because of overload, thus resulting in a total shut-down. After straight overload time-limit relays were substituted for the differential relays, on the occasion of several very severe short circuits the affected sub-station cleared itself in a perfectly satisfactory manner and without disturbing the rest of the system. It would appear, then, that the straight over-load time-limit relay is the most satisfactory device obtainable for the protection of feeders at the sub-station end."

Localisation of Faults in Cables.

OUR readers will remember Mr. J. Cleary's articles on "Faults on Underground Mains." Quite a lively correspondence in regard to some of his suggestions has recently been carried on in the *Electrical Review*. We reproduce herewith Mr. Cleary's reply to his critics, from which the various points raised will be clearly understood:

"The interest taken in the recent correspondence in the *Electrical Review* on fault-locating tests is certainly a good sign, as it shows that this important subject, although not valued at its true worth, is receiving some attention, and it is only by an

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interchange of opinions by those who are actually meeting and overcoming the various difficulties that solutions of any value can be obtained. Several correspondents referred to the 'Bergh' test, described by me some time ago in THE ELECTRICAL MAGAZINE; one writer even went so far as to question the origin of the test then described. I would, with your permission, like to state that this test was devised by Mr. Bergh over two years ago to overcome certain shortcomings of all other known tests. It is to be commended for its simplicity, accuracy, and quickness in application. It can be adapted to every conceivable kind of fault, and has been effective on a cable with two faults about 100 yards apart, in this case locating the largest first. I may here say, *en passant*, that this test has been successfully applied on a large network—and certainly one of the oldest—for over two years on both triple-concentric and single cables, ranging in size from 1 sq. in. to single arc lamp mains. There has been ample scope to prove the efficiency or otherwise of the test, and during the whole of that time it has never been found necessary to open consumers' switches or remove their fuses, as some of your correspondents seem to think.

"'B. S. H.,' writing in the *Electrical Review*, April 14th, 1905, says: '. . . I say it is absolutely imperative (if the test is to be a success) to draw consumers' main fuses or open their main switches, &c.' In reply to 'B. S. H.,' I would ask him to apply the test *as described*, and give us the benefit of his experience, as then his opinion will have some weight.

"'Weary Willie' and 'Tired Tim,' writing in the *Review*, April 21st, 1905, say: '. . . In these articles it is stated that the tests can be applied without access to consumers' premises . . . but *we* quite fail to understand how the test can be applied, &c., without opening consumers' switches.' My request to 'B. S. H.' also applies to 'Willie' and 'Tim,' but I do hope they will not apply the test until they do *quite* understand it. On May 5th the 'Weary' and 'Tired' couple make a very strong point (for them), they say that 'four out of the six tests given in THE ELECTRICAL MAGAZINE were made between the hours of 10 a.m. and 3 p.m.' I would here explain that these tests were given as an example, because they were consecutive and the most recent, and I entirely fail to see how this fact can be adduced against the efficiency of the test. On the other hand, I am sure that all engineers with experience on large networks will agree with me that this is an ideal time for taking off faults when the conditions are favourable. 'Willie' and 'Tim' are evidently more keen on finding evidence against, rather than for the test, or they might have observed that these tests were made in the middle of August, one of the lightest months of the year, and at a time when least light would be required, so that, as far as lighting consumers were concerned, little or no inconvenience would be felt. With regard to power-consumers, as a meal-hour generally intervenes between 10 a.m. and 3 p.m., it is a very easy matter to arrange to take tests during that time. Of course, all details of this sort must be considered on the spot, and are not worth discussing here. I repeat all that I said in my previous articles in favour of the test, as my experience since has more than confirmed what I then said, and as no one among your numerous correspondents has suggested any other method in preference to the 'Bergh' test, it appears to me that the latter is all I have claimed for it, and ranks well in front of all others.

"In conclusion, I would add that the testing set is well adapted for its work, and the saving of time alone very soon pays for its cost, apart from the great saving effected in re-instatement; and this latter, in these days of wood-block, asphalte, and other costly paving, cannot be ignored, as it may cost from 10s. to £1 per yard. Great care must be exercised in measuring the length of the cable, as it is here that the real difficulty presents itself. It is almost impossible to allow accurately for deviations due to pipes and other obstructions; but even allowing for slight errors in measurement, the fault is generally found within the length of the necessary joint-hole. My only excuse for trespassing on your valuable space is to emphasise that the test can be applied in a few minutes, *without* access to consumers' premises, and is reliable."

SUPPLY CABLES

will be dealt with in future articles in this section. . .

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Central Station Superintendents.

WE have heard a great deal lately of the keen rivalry between the three great classes of central station engineers:

1. The college trained man.
2. The premium pupil engineer.
3. The marine engineer.

The qualifications of the man who is ultimately to have the superintendence of thousands of pounds worth of electrical machinery, a portion of which can be ruined at a stroke, are not to be passed over lightly, and although no stringent rules can be applied to the training of such, certain definite governing factors obtrude, and their influence on the particular subject is vitally important. Mr. G. W. Hubley summed the case up well in a recent issue of *The Electrical World and Engineer*, and for the benefit of our central station readers we abstract a few of his remarks.

"The man filling such a position should possess the characteristics of honesty, concentration, perseverance, and conscientiousness of purpose. Essentially, a good education is requisite, and it is of special value for such to be of a technical nature, rather than of a practical one, although a proper combination of both is to be desired. However, the most important item in the education of a superintendent is that of logical reasoning power, in order that all theories and conclusions shall be well balanced, and their application to actual practice be made with regard to their commercial adaptability, as well as to their accuracy and precision as viewed from an engineering point of view. An engineering education is certainly most desirable, if not absolutely essential to the qualifications of a superintendent of the central station, in order that he may be prepared to successfully meet all problems which will be presented from time to time. The superintendent should be a good statistician, even to the extent of this characteristic being a "pet hobby." The value of keeping records and data of all details of work and station routine, especially as relating to costs, cannot be over estimated. It is necessary that a complete and thorough system for arranging such data be devised, in order that the various details of subjects can be properly classified and indexed and at all times be conveniently and readily available for reference. Like wine of early vintage, their value increases with age, for it requires some time before any correct deductions can be taken from compiled data. With complete detail data, it is possible to adopt certain standards in particular lines of work, and the incentive to improve and raise these standards is one that inspires ambition in the superintendent and his assistants. The superintendent who is a close student of human nature, and is capable of discerning the qualifications and characteristics of other men, will find this talent of greatest value in his judgment of selection of employees and the assignation of the man of proper calibre to the class of work to which he is best fitted, and when opportunity for advancement or promotion of old employees is presented, the task of selection of men best adapted for the new opening will be facilitated. The superintendent will find it most valuable to associate himself in the membership of the leading engineering societies in the country, and, as far as it is practicable to do so, to give his support and take active interest in their affairs by contribution of original papers, or taking part in discussions. The records of such societies act as a reservoir for the storage of knowledge, and the privileges of membership are most valuable to the successful man of this profession. Not less in importance is the necessity of reading the leading engineering and technical publications, and in this regard it is necessary to use careful discernment in selecting the periodicals which are to be adopted for regular and systematic reading. Most valuable suggestions are to be obtained from the articles descriptive of new installations, and by such information one can keep informed of the progress and development of other plants. It is, of course, necessary that the superintendent follow the review of standard books on special subjects relating to his work, and, in general, to keep pace with the times by reading of all new work, or proposed plans of systems for the central station."

YOUR ATTENTION

is directed to the notice at the foot of the next page.

Read and act upon it.

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Automatic Synchronising.

THE perspiring excitement of synchronising is now to be a thing of the past. The shift engineer, the underpaid switch men, and the over-anxious student will ere long have ceased to rival Brock's pyrotechnic displays and disturb the chief's equanimity with a bad "plug in." What was more exhilarating than the thought of paralleling coreless alternators during a fog or the passage of storm clouds! Why, the very act of synchronising gives an extra tilt to the nose of the alternate-current engineer, and makes him feel (though it doesn't get beyond that) he is worth "thirty bob a week" more than his direct-current rival. One-phasers and poly-phasers please note that these things are now no more—the automatic synchroniser is a *fait accompli.* The man who invented it lives in Pittsburg, so if you want to wring his neck you have got a long way to swim.

The apparatus comprises an electromagnetic synchroniser, an electromagnetic relay switch controlled by the synchroniser, and a similar switch arranged to connect and disconnect the alternator or converter and controlled by the relay switch. The connections are clearly shown in the figure. Referring to this, the main switch is provided with two actuating coils, one for closing it and the other for tripping it and allowing it to open; presumably, it is held closed by a latch and provided with a spring tending to open it when the latch is tripped, like a circuit-breaker. The hand controlling switch, when thrown to the right, puts the main switch in condition to be closed by the relay switch; when thrown to the left, it energises the tripping coil and causes the main switch to open. The synchroniser switch merely connects the solenoids of the synchroniser to the potential transformers. One of these takes current from the bus bars and the other from the incoming machine.

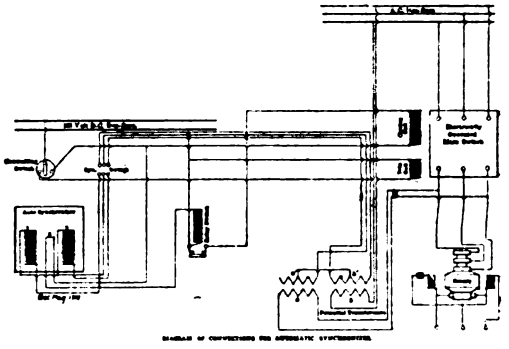


FIG. 1.

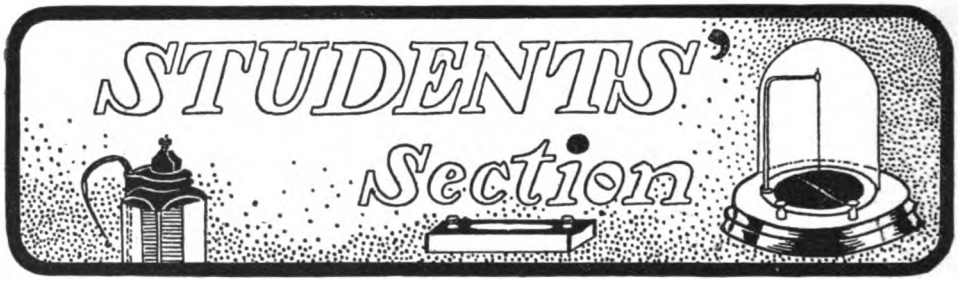
When the incoming machine is sufficiently near to synchronism with the bus bars to allow for the brief time required for the operation of the switches, the synchroniser closes the circuit of the solenoid on the relay switch, and that switch promptly closes the circuit of the closing coil on the main switch, which thereupon connects the incoming machine to the bus bars. As just intimated, these consecutive operations require a very brief time period, and the synchroniser is calibrated to allow for this, so that when the main switch actually closes the incoming machine will have reached precise synchronism—unless the phase difference is varying too rapidly for successful paralleling, in which case the synchroniser will fail to close the circuit of the relay switch and thereby prevent miscoupling. This is accomplished by means of an ingenious attachment in the synchroniser which withdraws one of its contact brushes when the frequency of the incoming machine differs greatly from that of the active machines; as the difference in frequencies become less this device allows the synchroniser contacts to be closed ahead of the instant of synchronism by a margin corresponding to the time element of the magnetic switches.

Every Central Station Engineer will want *our July issue.*

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Students should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles of special interest to them.

Problems on Distributing Networks.—VII.

By ALFRED HAY, D.Sc., M.I.E.E.

(Continued from p. 471.)



IN the diagram of Fig. 23 are marked the conductances of the various members of the network, and the nodal currents corresponding to the second imaginary distribution. Let v_A, v_B, v_C, v_D, v_E and v_F denote the drops of potential from either feeding-point to the corresponding nodes. These will be our unknown quantities, and it is obvious that if we can determine them, then the current distribution in the network becomes known.

Equations for finding them are easily obtained by expressing the fact that the algebraical sum of the currents flowing towards any node of the network is equal to zero. Thus, taking the node A, we have for the currents flowing towards it:

Currents flowing towards A from

$F_1 = v_A \times$ conductance of $F_1A = 100v_A$

$B = 25\ (v_A - v_B) = 25v_A - 25v_B$

$C = 17.86\ (v_A - v_C) = 17.86v_A - 17.86v_C$

$D = 10v_A - 10v_D$

$F = 8.33v_A - 8.33v_F$

In addition to the above, we have the load current of 155.8 amps., which, since it is flowing away from A, must be taken with the negative sign. We thus get, forming the algebraical sum of all the currents,

$$(100 + 25 + 17.86 + 10 + 8.33)\ v_A - 25v_B - 17.86v_C - 10v_D - 8.33v_F - 155.8 = 0$$

It will be noticed that the coefficient of v_A in this equation is the sum of the conductances of the various distributors which radiate from A to other nodes of the network or to feeding points. The coefficients of the remaining v's are negative, and are numerically equal to the conductances of the distributors corresponding to the different suffixes of the v's. The law of forming the equation corresponding to any node now becomes evident: we multiply the drop corresponding to this node by the sum of the conductances of the various paths leading towards it, and from it subtract the products of the drops corresponding to other nodes which are in immediate connection with the given node, into the conductances of the corresponding paths; we finally subtract the load current at the node, and equate the result to zero.

The equation corresponding to any node may be conveniently referred to in terms of the letter by which the node is denoted;

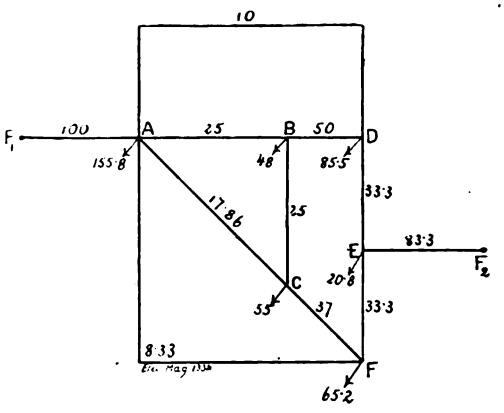


FIG. 23.

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thus, we may speak of the above equation as the A equation.

In order to enable us to write down the entire system of equations without any complications, we shall, as a preliminary step, determine the sum of the conductances of the paths meeting at each node of the network. This is done in the following table :

Node.	Sum of conductances of paths leading to node.
A	100+25+17.86+10+8.33=161.2
B	25+25+50=100
C	17.86+25+37=79.9, say 80
D	10+50+33.3=93.3
E	83.3+33.3+33.3=150
F	8.33+37+33.3=78.7

The values given in the table have been rounded off, as extreme accuracy is not required in problems of this kind. Making use of this table, we next write down the required system of six equations.

$$161.2v_A - 25v_B - 17.86v_C - 10v_D - 0 - 8.33v_F - 155.8 = 0 \quad . \quad (1)$$

$$-25v_A + 100v_B - 25v_C - 50v_D - 0 - 0 - 48 = 0 \quad . \quad (2)$$

$$-17.86v_A - 25v_B + 80v_C - 0 - 0 - 37v_F - 55 = 0 \quad . \quad (3)$$

$$-10v_A - 50v_B - 0 + 93.3v_D - 33.3v_E - 0 - 85.5 = 0 \quad . \quad (4)$$

$$-0 - 0 - 0 - 33.3v_D + 150v_E - 33.3v_F - 20.8 = 0 \quad . \quad (5)$$

$$-8.33v_A - 0 - 37v_C - 0 - 33.3v_E + 78.7v_F - 65.2 = 0 \quad . \quad (6)$$

We must now explain the method adopted by Seydel for solving such equations. The first step is to guess rough values for the variables. The more nearly correct the guess, the shorter the labour involved in finding exact values. Consider the variable v_A. If the current along F_1A were merely that which branches off at A, v_A would be equal to 155.8 100 (= current × resistance) = 1.558 volts. If, on the other hand, the currents at B, C, D and F were also all supplied from F_1, then the total current along F_1A would be 155.8 + 4.8 + 55 + 85.5 + 65.2 = 409.5, and the corresponding drop v_A would be 4·095 volts. Now a glance at Fig. 23 is sufficient to show that it is extremely unlikely that the feeding-point F_1 supplies no current beyond A, and that it is equally unlikely that, in addition to supplying the current at A, it also supplies the whole of the currents at B, C, D and F. We infer that the actual current along F_1A must lie between those limits, and are thus, as a first rough guess, led to adopt $\frac{1}{2}(1.558 + 4.095) = 2.82$, or, say, 2·8 volts for the value of v_A. Similarly, we estimate the value of v_E to be $\frac{1}{2}(.25 + 2.05) = 1.2$ volts, say. Next, we may estimate the drop along AB to be 48/25, or, say, 2 volts, so that $v_B = v_A + 2 = 4.8$ volts; v_D may be taken to lie about half-way between v_A and v_E, so that $v_D = \frac{1}{2}(4.8 + 1.2) = 3$ volts; v_F may be roughly assumed to be equal to v_D, so that $v_F = 3$; and finally, v_C may be taken to have the same value as v_B, *i.e.*, $v_C = 4.8$ volts.

We therefore assume

$$v_A = 2.8 \; ; \; v_B = 4.8 \; ; \; v_C = 4.8 \; ; \; v_D = 3 \; ; \; v_E = 1.2, \text{ and } v_F = 3$$

as first rough approximations.

We have now to ascertain in how far these values satisfy our equations. We accordingly substitute them in the equations, and find, as a general rule, that the left-hand sides of the equations do not vanish, but differ from zero by a greater or less amount, according to the accuracy of our guess. Let us denote the values of the left-hand members of the equations (obtained on substituting the assumed values of the v's) by E_A, E_B, E_C, ... E_F (the letter E denoting the *error* in each equation). We thus find :

$$E_A = 451.36 - 120 - 85.728 - 30 - 24.99 - 155.8 = +34.84$$

$$E_B = 480 - 70 - 120 - 150 - 48 = +92.$$

$$E_C = 384 - 50 - 120 - 111 - 55 = +48.$$

$$E_D = 279.9 - 28 - 240 - .40 - 85.5 = -113.6$$

$$E_E = 180 - 99.9 - 99.9 - 20.8 = -40.6.$$

$$E_F = 236.1 - 23.3 - 177.6 - 40 - 65.2 = -70$$

The greatest error occurs in equation (4). Now the variable having the highest coefficient in (4) is v_D; we therefore, provisionally, attribute the entire error to v_D, and, in order to correct it, we alter v_D by an amount Δv_D such that $93.3\Delta v_D = 113.6$, which gives for Δv_D the value 113.6/93.3, or, say, 1.2. The change from the original value of v_D to its new value $v_D + \Delta v_D$ will obviously alter the errors in all the equations. Recalculating these errors, we find :

$$E_A = 34.84 \quad 10\Delta v_D = 34.84 - 12 = 22.84$$

$$E_B = 92 - 50\Delta v_D = 92 - 60 = 32$$

$$E_C = 48 \; ; \; E_D = -113.6 + 93.3\Delta v_D = -1.6$$

$$E_E = -40.6 - 33.3\Delta_D = -80.56 \; ; \; E_F = -70$$

The greatest error, it will be noticed, is now less than before. We again correct the value of the variable having the highest coefficient in the equation whose error is greatest. This variable is v_E. Taking

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$\Delta v_x = 80.56/150$, or, say, $\Delta v_x = .5$, we find for the new values of the errors.

$E_A = 22.84$; $E_x = 32$; $E_c = 48$

$E_D = -1.6 - 33.3\Delta v_x = -18.25$;

$E_x = -80.56 + 150\Delta v_x = -5.56$;

$E_y = 70 - 33.3v_x = -86.63$.

The greatest error is now $E_y = -86.63$, and we again correct by taking $\Delta v_y = 86.63/78.7 = 1.1$, say. This gives for the new errors:

$E_A = 13.68$; $E = 32$; $E_c = 7.3$;

$E_D = -18.25$; $E_x = -42.19$; $E_y = -.06$.

*Various Kinds of Education.**

By WALTER C. KERR.

THE world wants men who can do things. Cornell has always done things, and the habit is infectious. There is a peculiar bull's-eye directness about the Cornell motive that counts. It is not probable that a few thousand young men assembled at random in one place differ materially from a like number assembled elsewhere, except as they are attracted by something that consciously or unconsciously appeals to them. The older institutions attract students rather better prepared, with more antecedent educational atmosphere, financially more able to pay for advantages, but also a large number who lack serious motives. Cornell, on the other hand, attracts a very large percentage of men bent on serious missions though not indifferent to the colours that add to the good cheer of nations. On this material Cornell places her stamp of knowledge for action, and measures acquirements by results, not by the capacity to contain. I don't know why anything need be said about education on an occasion like this. If we haven't got enough education we aren't likely to get much more by talking about it, and if we have enough the time might be better spent on something we haven't got. However, as the education we received and the conditions under which we received it underlie the motives of our gathering, it is of some interest to us what trend education is taking, if we are interested in what our sons will get. "The results of things follow not so much from their state as from their tendency," and so our interest is not so much in the kind of education that is being given at the moment as in the tendencies marked by the changes which determine what it will become.

Cornell has played an active part in the development of education in this country. It started with strong initiative force through men who felt but hardly dared formulate their inclinations towards something which was better than that which had been. They were men who reached forward from the limitations which compressed their past to aspirations which they could not quite measure or define. Nevertheless, in some way, consciously or unconsciously, there evolved from and through these men the power to do things which, though simple in themselves, were far-reaching. I regard as the first of these the declaration that all kinds of education are equal. The democracy of this is so simple as to seem axiomatic, but that it was a departure is shown by the fact that after nearly forty years it is not yet quite universally believed. The second I believe to be the proper view of the relations between the so-called liberal and utilitarian courses of study. The third may have been the bold willingness to do the right thing every day and all the time as opportunity offered, without too fixed a goal, but trusting that the results would be the best that right could make. They went as far as they could see and then saw how far they could go. This underlies the pioneer spirit. Men do not know what they are going to make of a new country and its resources, but they plunge in, turn it over, and make of it the best they can; always in the spirit of industry and honesty; with that aspiration for betterment which invariably turns to good that which is worthy and turns to naught that which is undesirable.

Thus Cornell started—with no entrammeling traditions, no compressing environment, surrounded only by the four winds of heaven, the courage of her convictions making her superior to criticism. The result was a new kind of institution. It was called a poor man's college, for reasons we all know. It has since remained a poor man's college, but poor men are not quite so poor as they used to be, and it would be strange if they were, amid all the resources of this great country. Then followed the years of struggle filled with incidents which form the oft-repeated history of the early days. The day came, however, when, through the sale of lands, the gifts of many

* Taken from an address at the annual dinner of the Cornell University Alumni at Chicago, April 1, 1905.

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benefactors, and the added talent of an ever-increasing faculty, we had a well-rounded university. This was the result of influences which for a score of years had, from the rude beginnings on the Ithaca hill, shaped the ends which have reached deep into other institutions of learning throughout the land. As a result we have 3,100 students, departmented as follows: Post-graduates, 200; Arts, 700; Law and Medicine, 600; Applied Science (chiefly engineering), 1,600. Contrast this condition, where only one-fourth of the students are in Arts course, with the old academic institutions with an eye to what education should consist of when a large number of intelligent men are left to freely choose what is best adapted to their needs. The fact that under these conditions so few elect the humanities has often been deplored as the decadence of classical training. I do not think so. It is rather the beginning of a higher development in which the classical will be more effective because not diluted with the dregs of its own failures. The time was when but one kind of education was known, or at least only one kind of training was called education. Our early colleges were therefore strictly classical, and many are yet. An educated man was then perforce a classical man, and since education led chiefly to the learned professions, the few who in the early days received college training were fairly fitted for their life's work. Then the so-called blind impulse for the old ideal of general culture led fewer men astray than it does now. As time went on, institutions grew in size and multiplied in number. Thousands of students took the place of former hundreds.

After a time we began to hear whispers from the practical world, which generally gets things pretty nearly right, that college education was a failure; that men who spent four years and thousands of dollars in academic halls were less fitted for the activities of the world than those who spent these developing years in business or other pursuits. Educators used everything from argument to ridicule by way of refutation, commonly alleging that men without education were unfitted to judge the product of our institutions. I think the apparently crude judgment of the world was right and the ineffective theories of many refined educators wrong, and for no uncertain reason. I think the whole problem is so simple that a few statements can take the place of argument, and especially of contention. Humanity is composed of all kinds of men, possessing widely different temperaments, tastes and abilities. It is well they are not all alike. Any man will achieve the greatest effectiveness when given the opportunities and training which develop his native powers. Any other training is liable to stunt his growth. His variation, as he progresses in development, should be in the direction in which he tends to vary. This assists in the survival of the fittest; the survival of the unlike, the survival of the effective. Manifestly there must be as many types of education as there are types of men, and fortunately the number is not so great but that they can be readily supplied within any university. So long as all men during the process of education were confined to one channel, those whom the channel precisely fitted were greatly benefitted. Those for whom the channel was a misfit were injured, for the reason that during the most important formative period of their development their native power to vary was resisted, their minds forced away from their natural trend, and energies which could have been potent for good in certain directions were dwarfed by the compulsory exertion of uninteresting, unproductive effort. This results in that kind of mediocrity which is stagnation.

You can't make anything good of a man except to make him better in that which he is. You can't unmake him and make him over again. If it be argued that a man must needs have the so-called liberal education in order to be well rounded, following this with the so-called specialized courses, the answer is that he can be forcibly made well rounded like a billiard ball without other characteristic than roundness. He ought to have corners, and the corners should be left on to dent something. As to the so-called specialized courses, these are only names. They are no more special than the humanities. Some are scarcely so highly specialized. The older I get, the more I think that there is no such thing as liberal education, liberal arts, or liberal anything, as distinct from specialized departments of knowledge. Liberality is the free and equal admission of all. We have heard too much about knowledge for its own sake versus knowledge for use. All knowledge is for use. All education is for action. The

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engineer uses mechanics and thermodynamics in a certain direct way. The architect uses art and constructive knowledge in a similar way. The lawyer uses his knowledge in a less material way. The classical or philosophical man uses his acquirements in a different way, but if he does not use them they are useless. All education is liberal or all is technical according to our definitions, but all is for use.

When it is observed that less than 25 per cent. of the students follow classical pursuits when left free choice, and that over 75 per cent. select professional and industrial education, there is good reason to believe that this is about the proportion in which men's minds are fitted to receive benefit from the acquirement of the respective classes of knowledge and training. I therefore maintain that instead of a decadence in the humanities they are elevated, because their representatives are men whose minds are fitted to take such education and who will therefore conspicuously represent the best possibilities of classical training applied to those to whom it is adapted. Likewise by processes of natural selection the other departments will have graduates who are conspicuously strong because their best efforts will be put into that which they can do best. I know of nothing pointing more directly to success than that. It is not necessary to consider the relative merits of the various kinds of education. There is room for all, because there are all kinds of men. It is useless to say I am better than thou, or this is better than that. But one thing is better than everything else, and that is the broad spirit which recognises that all education is equal, that training is training whenever you find it, knowledge is knowledge, no matter of what it consists, that human effort is human effort, no matter to what it is applied, and when it has singleness of purpose and is resourceful, it is effective.

From Professor to Student.

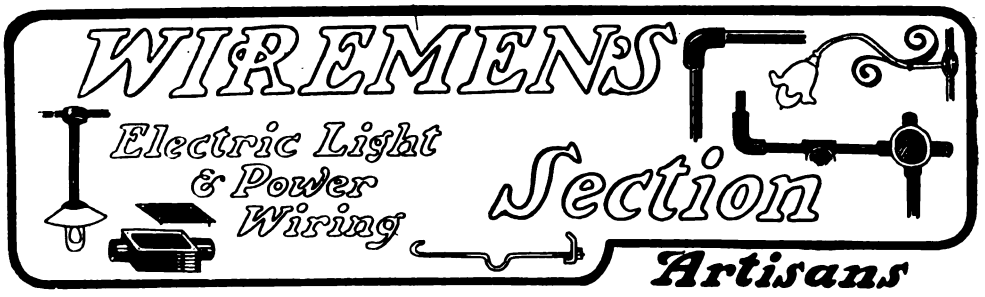
Would you kindly let me know the composition of the agglomerate blocks of Leclanché cells? What is the binding material used, and why have these cells with blocks not come more into use? What are their defects? What is the material added to the acid in some accummulators to form a jelly?

The composition of the material used in forming the agglomerate blocks of Leclanché cells—an arrangement first introduced by Leclanché in 1871—is as follows: 40 parts by weight of granulated manganese dioxide, 52 parts of granulated carbon, 5 parts of gum shellac, 3 parts of potassium sulphate, and a small amount of sulphur. The mixture when made up is heated to about 100°c., and is then formed into the required shape by being strongly compressed in moulds. In this process, the sulphur is practically driven off by the heat, and the resultant blocks are highly porous. The above composition is that originally employed by Leclanché, but modern manufacturers vary it at their discretion; a binding medium very commonly employed is resin. Our correspondent is certainly mistaken in supposing that the agglomerate block type of cell is not used to any large extent; and so far from possessing defects not exhibited by the porous pot cell, it has, on the contrary, the advantages of a lower resistance and less rapid polarisation (it is slightly more expensive, as regards first cost, than the porous pot form). The invention of a jelly electrolyte for secondary cells is due to Dr. Schoop. This electrolyte is prepared by adding to one volume of dilute silicate of sodium having a specific gravity of 1.18, three volumes of dilute sulphuric acid of specific gravity 1.25. After the lapse of some twenty-four hours, the electrolyte so prepared will set into a jelly.

We want Students to use this Section for the expression of their opinions on current electrical affairs.

Our Students' Scheme will specially interest you. Send for full particulars.

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Wiremen and Artizans should refer to the World's Electrical Literature Section at end of Magazine for classified list of articles on subjects of importance to themselves.

The Installation and Wiring Connections of Generators and Motors for Direct and Alternating Currents.

By STUART A. CURZON

(Continued from page 484.)

TAKING D.C. generators and motors we have series, shunt, and compound windings.

Series Dynamos are not in great demand and are only to be found in such cases as arc lamp lighting where the amount of current flowing remains the same but the voltage is varied according to the number of lamps in use. There are three accepted methods of regulating the voltage of series dynamos. They are :—

(1) By using an automatic electrical device for governing the engine.
(2) By moving the brushes.
(3) By inserting a variable resistance as a shunt to the field coils

In a series machine the whole of the current generated flows through the field coils, which are of larger section wire than those of a shunt-wound machine. The windings of a series dynamo are shown in Fig. 5. Two points with this class of machine which have caused it to be dropped from general use are the difficulty of keeping a constant voltage and the fact that it is liable to reverse its polarity.

The Series-wound motor has but little favour for ordinary purposes, as it has many defects. Nevertheless it has its own particular sphere of usefulness, such as for trams and cranes. It can in these cases be safely employed, but it is of no use for intermittent driving because immediately the load is removed the motor runs away. Its speed varies with the load, making it useless for machine shops, etc. Fig. 6 shows the connections necessary. The windings are as in Fig. 5.

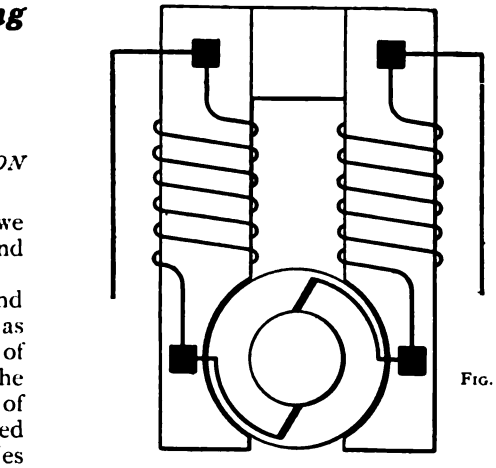


FIG. 5.

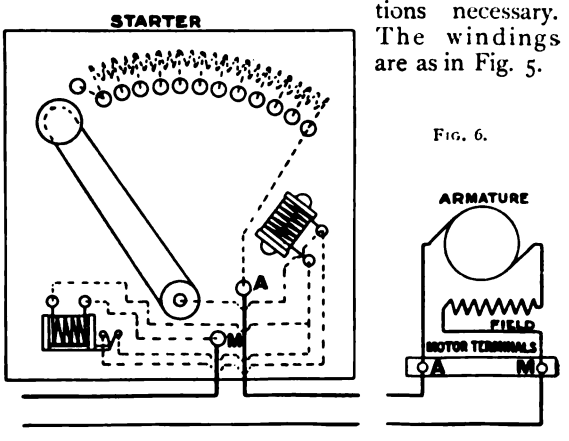


FIG. 6.

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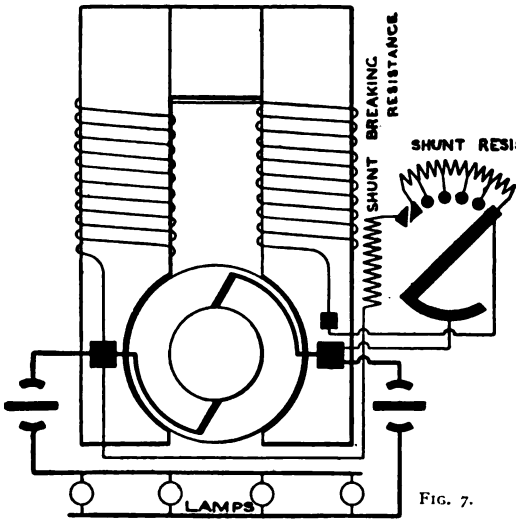


FIG. 7.

The next type is the shunt-wound generator, as shown in Fig. 7. This is the machine used for charging accumulators and for most purposes it is generally found satisfactory. The method of connecting this machine is clearly shown and should be sufficiently remembered so that references to diagrams are unnecessary. It is not safe to break the shunt of a dynamo when excited, as there is a great risk of injuring the insulation of the machine through inducing a high voltage in the windings. In the diagram (Fig. 7.) is shown a rheostat manufactured by Verity's which effectively safeguards the machine by connecting the resistance in parallel with the shunt windings before the circuit is broken.

Two or more such machines are often run in parallel, and Fig. 8. shows the necessary connections. In large works this method of running is very frequently adopted—our machine being sufficient during the day and the other or others being cut in when the lighting load comes on.

Again, two shunt-wound machines may be coupled in series, giving double the voltage on the outers. This is very useful where a lighting and motor load is required—the former being supplied at 220 volts, and the latter at 440 volts (say), Fig. 9.

There is considerable saving in this method, the difference in cost of cable alone being a large item. Of course it is necessary to split the lighting load so as to get an equal amount, or as near as possible, on each side.

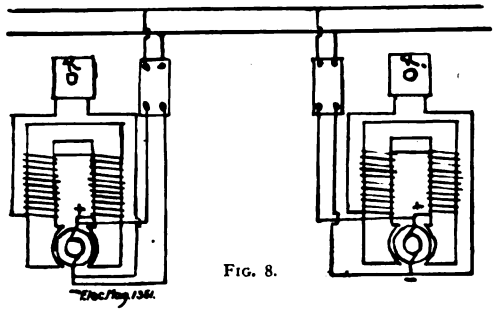


FIG. 8.

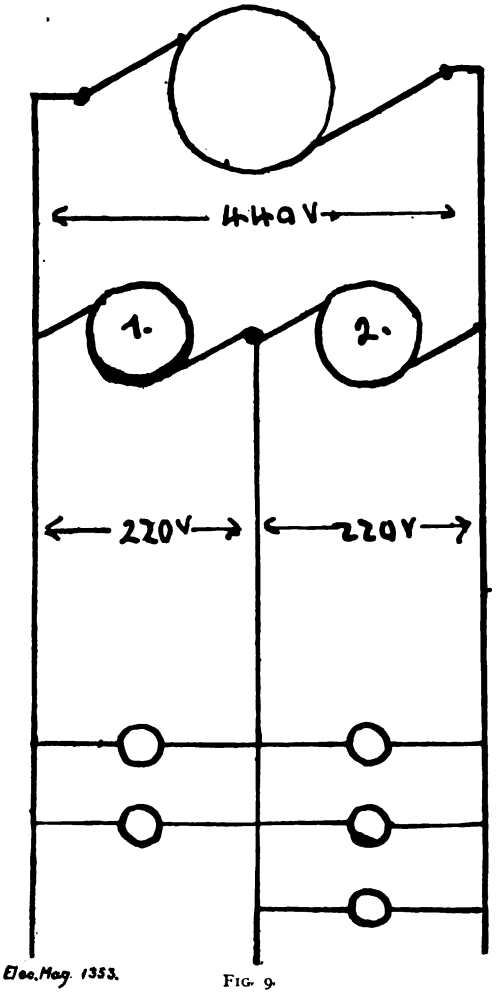


FIG. 9.

In connection with large plants it is often used in the way described in Fig. 10, and thereby the balancing current is obtained from an independent source.

The two small machines 1 and 2 are mechanically coupled together, and as long as the load is equally distributed do no work.

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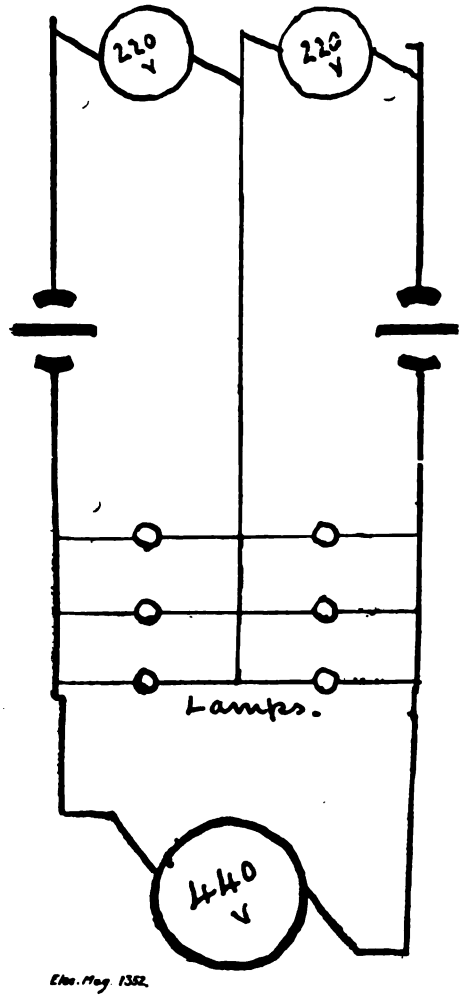


FIG. 10.

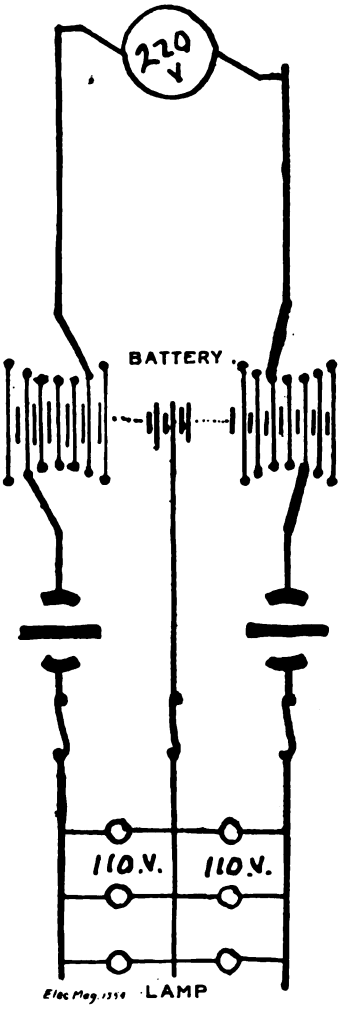
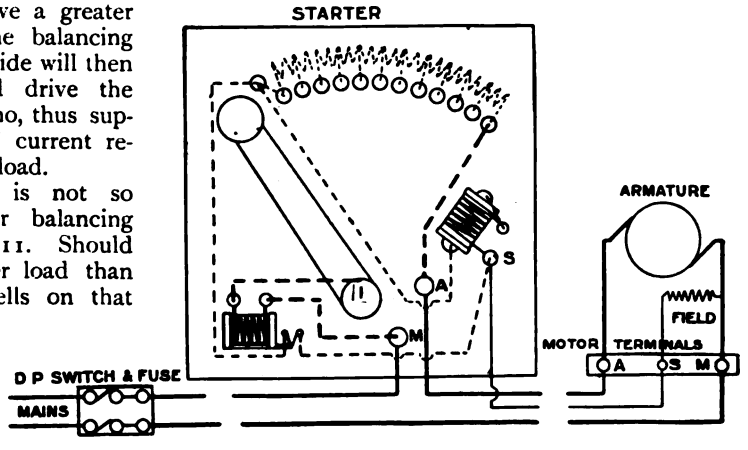


FIG. 11.

Should the side 1 have a greater load than side 2 the balancing machine on the latter side will then run as a motor, and drive the machine 1 as a dynamo, thus supplying the amount of current required to make up the load.

Where the system is not so large the accumulator balancing set is preferable—Fig. 11. Should one side have a higher load than the other, then the cells on that side discharge in parallel with the generator, thus helping out the load, while the cells on



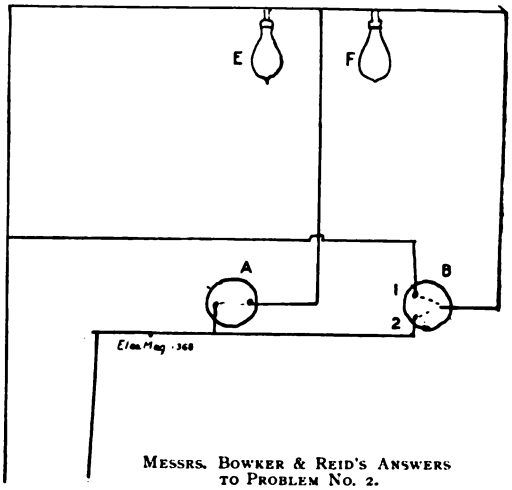
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the opposite side receive a corresponding charge current.

The Shunt-wound Motor is the most frequently used, and Fig. 12 shows the method of connecting same. This type of machine runs at practically constant speed—an automatic no-volts and overload release are necessary, and only such "starters" as have these attachments should be fixed. It is necessary when wiring for these motors to use wire of sufficient capacity to carry current required with as small a drop as possible, as any variation in the voltage alters the speed of the motor.

(*To be continued.*)



MESSRS. BOWKER & REID'S ANSWERS TO PROBLEM NO. 2.

Our Problems.

PROBLEM No. 5.

This month we give an easy problem in Dynamo faults.

A new machine has just been installed. All terminal connections have been properly made, and proper speed attained. There is no voltage on the armature. The machine has been excited from another source, causing a strong current to flow through armature with very excessive sparking. Armature becomes overheated. What is the matter and how can it be rectified?

Answer to Problem No. 2.

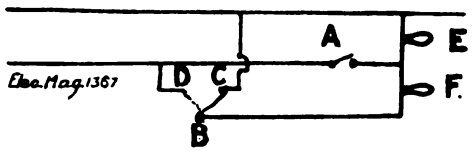
Herewith we give two solutions of above problem which we consider the best sent in. Both Mr. Bowker and Mr Reid obtain the desired result in the simplest way.

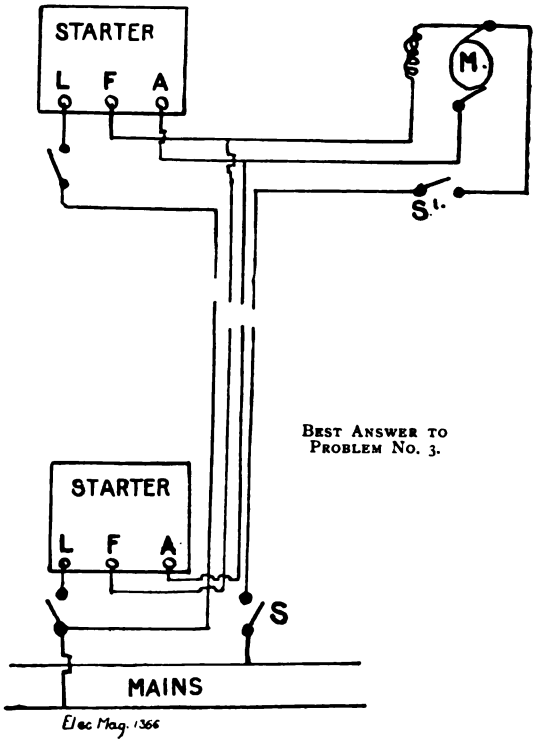
Answer to Problem No. 3.

This seems to have caused a large amount of interest, judging by the many replies received. Most of these, however, miss one important factor. The motor is to be controlled by either starter. If started at one it may be stopped at the other. The illustration given shows the most satisfactory method.

To stop motor from either position open either of switches S or S^1, so that starter arm returns to off position. Then close switch again.

There is a still better method whereby efficient control may be obtained with only one starter. How is it done?





BEST ANSWER TO PROBLEM NO. 3.

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"The Electric Tramcar Handbook."

By W. A. AGNEW. London: H. Alabaster Gatehouse and Co., Ludgate Hill, E.C. Price 2*s.* 6*d.*

This little work, though claiming to enlighten the general public on the subject of electric trams, is essentially a motor-man's book. Its first good feature is its convenient size. It is christened a handbook, and does not belie its name. The introduction gives some sound practical advice to motor-men which may be read with advantage. The seven chapters deal with the electric circuit, electric tramways, electric tramcars, controllers, brakes, on the road, and faults and breakdowns. The entire gamut of operating electric traction is run over, and the information given is essentially serviceable and concise. The illustrations are good, and the diagrams a pattern of clearness. Every electric tramcar operative should have a copy.

"Technological and Scientific Dictionary."

Edited by G. F. GOODCHILD, B.A., and C. F. TWEENEY. Geo. Newnes, Ltd., Southampton Street, W.C. In 15 parts, price 1*s.* each.

The dictionary before us should fill a long-felt want, and occupies a distinct gap between the usual philological compilation and dictionaries devoted exclusively to some special branch of science or art. It defines terms occuring frequently in the daily press which convey nothing to the lay mind and are passed over without being understood. Of the various branches of engineering, civil, electrical, and mechanical—some 6000 terms are explained. In addition there are numerous articles which we may refer to as being essentially of electrical interest, on accumulators, armatures, electrical measurements, dynamos, prime movers, radium, wireless telegraphy, &c. The dictionary might well be invested in by students, trained mechanics, and professional men.

"The Motor-man and His Duties."

By L. GUTMANN. 5th edition. Revised and enlarged by G. R. Metcalf. Chicago and London: Windsor and Kenfield Publishing Co. Price 4*s.* 6*d.*

This work is somewhat similar in its object to the volume reviewed above. It is written for the motor-man, but primarily for the American motor-man. The reader is mentally conducted at the outset over the equipment of a car—presumably to concentrate his attention. He is then told how electric power is generated and transmitted to the line and cars. Car-driving and controllers are then brought to his notice, following which comes information on brakes and the remedy of troubles. This concludes Part I. The second part opens with a few doses of theory, the principles of motors being clearly dealt with. By this time the reader should know a little about tramcar motors, and will be in a position to absorb the data as to their connections and control. Electric train drivers will be interested in a chapter on multiple unit systems, this somewhat complicated subject receiving special treatment. Brakes come in for a full description, and the work ends with a chapter on electric traction systems. There is also a useful glossary of terms. The book contains much useful information, and although the price is not disproportionate to either the information or the style of the work, it seems rather high for the average motor man.

"N-Rays."

A collection of papers communicated to the Academy of Sciences by R. BLONDLOT; translated by J. GARCIN. London: Longmans, Green & Co., Paternoster Row, E.C. Price 3s. 6d.

So great controversy has arisen out of the startling researches of M. R. Blondlot that no good purpose will be served in adding thereto, when reviewing the memoirs of that eminent scientist (shall we say metaphysician?), published for the first time in volume form in English. Indeed, the reviewer's task in the present instance cannot be raised to the level of criticism of facts set forth as the result of long, patient, and sometimes painful research. Investigations such as those described in these memoirs are interwoven with threads of too fine a texture for the reviewer to handle, and rather than damage the fair form in which he receives them, he assumes the rôle of chronicler rather than of critic.

Keener interest should centre in the little volume before us because of the series of articles now publishing in this journal from the pen of the translator of the memoirs in question. The memoirs themselves, it may be stated at this juncture, suffer little at the translator's hands, at any rate, as far as the average reader is concerned, and even here the spirit of the text is fully preserved. The exacting physicist may, however, observe peculiarities in phraseology sufficiently pointed to arrest his attention and occasion a moment's reflection as to how he would have expressed himself.

The various chapters of the book, comprising as each does the original paper presented to the *Comptes Rendus*, are a complete record of M. Blondlot's researches, and from his earliest discovery of "N-rays,"—through all their observed properties, peculiarities, and actions, to the methods of verifying the experiments conducted with them, the trend of thought can be easily followed. Some satisfaction can also be derived by the interested reader from the ease with which certain investigations can be

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conducted by himself. Even the simplest experiment he is persuaded to attempt, for a fluorescent screen accompanies each volume, and the most minute instructions are included for its use, so that failure, should it result, can only be attributed to personal incapacity or "cussedness." This element of personal experiment will probably bring to M. Blondlot and his fellows the fulfilment of a desire doubtless existing, to dispel the scepticism attaching to their work, for with the balance of evidence supporting their contentions, a full recognition of their labours at the hands of science would be a complete and just reward. With the "logic of the stricken field" behind them, they might thus claim an indisputable victory. To those of our readers interested in the phenomena of N-rays, we can heartily recommend the memoirs; and Mr. J. Garcin's articles will be found an excellent introduction to the subject.

"Das Funken von Kommutatormotoren, mit Besonderer Berücksichtigung der Einphasen-Kommutatormotoren."

(The Sparking of Commutator Motors, with special Reference to Single-Phase Commutator Motors.) By F. PUNGA. Hannover: Gebrüder Jänecke. Price M. 4.60.

The problem of sparkless commutation is one which has claimed the attention of numerous investigators, and provoked much controversy. In the little book under review, the author gives an exceptionally clear account of the conditions which must be fulfilled in order to secure sparkless running in both continuous and alternating-current machines. The greater part of the book is, however, devoted to the various types of single-phase commutator motors, and in view of the great interest which these motors now possess, this part of the work should prove of great value to all interested in the design and working of such motors. It is to be regretted that, in dealing with *reactance voltage*, the author attributes to it a somewhat different meaning from that assigned to it by Parshall and Hobart, who first introduced the term. The author's value corresponds to the arithmetical mean of the voltage induced by the current reversal, and is thus $\frac{2}{\pi}$ times the reactance voltage as defined by Parshall and Hobart. Mr. C. C. Hawkins has recently also advocated the use of the arithmetic mean, and has proposed to term it "inductive voltage." Nothing but confusion can result from such playing fast and loose with a term which has become thoroughly well established.

The author's method of treatment is characterised by extreme simplicity, elaborate analytical investigations being avoided, and everything being subordinated to the ultimate end in view —the establishment of reliable criteria for the practical engineer and the designer.

"Gleichstromerzeuger und-Motoren, Ihre Wirkungsweise, Berechnung und Konstruktion."

(Continuous-current Generators and Motors. their Action, Calculation and Construction.) By W. WINKELMANN, Hanover: Jänecke. Price M. 3.40.

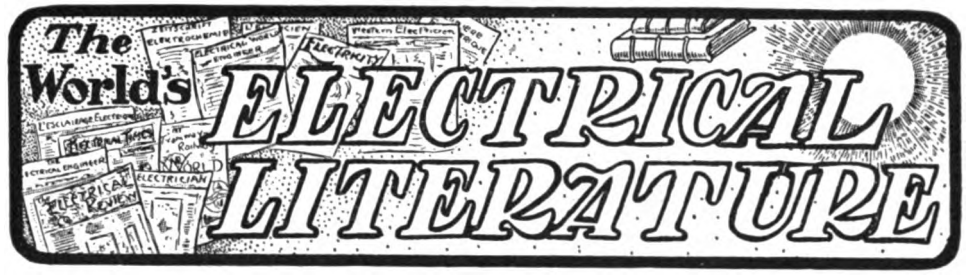
This little book of 124 pages forms Vol. III. of a series known as *Repetitorien der Elektrotechnik*, and contains a vast amount of information compressed into a surprisingly small space. The introductory chapter deals with general principles, methods of excitation and characteristic curves. The author then plunges into the heart of his subject, and considers losses and efficiency, heating, calculation of field ampere-turns, commutation and armature reaction. The principles and methods of design are next considered in detail. All this occupies only the first eighty pages of the book. The remainder is devoted to a fully worked-out design for a 25 kw. 230-volt shunt-wound dynamo. A large number of formulæ extremely useful to the designer are given, and the book is replete with the most up-to-date and practically useful information, all needless theoretical discussion being carefully avoided. In view of the highly condensed form in which the information is supplied, it is not surprising that occasionally there is a sacrifice of strict accuracy: thus on page 5 it is stated that a series-wound machine running on open circuit gives zero p.d., the effect of residual magnetism being ignored. We have, however, failed to detect any serious inaccuracies, and can confidently recommend the book to student and designer alike.

"Electric Lighting."

A Practical Exposition of the Art. Vol. I. Generating Plant. By F. B. CROCKER. New York: D. Von Nostrand Co. 1904. Price 12s. 6d.

A number of books essaying to deal in a comprehensive manner with the whole subject of electric lighting have appeared from time to time. The volume before us is one of these. There is first a good history of electric lighting, and some comprehensive and well classified data on central stations, preceded by chapters on units and measures and electric lighting systems. There are several good chapters on prime movers, notably the gas engine, though this subject might have been dealt with more fully. The principles and construction of dynamo electric machines are clearly enunciated, the chapters on the design of generators being thoroughly practical, and should make easy reading for the average engineer. The practical management of dynamos has a chapter to itself, and contains much useful operating data. The book should prove a useful addition to the library of station engineers and men in charge of isolated plants.

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You should carefully study this Section, as it will save you much valuable time. It is the key to the world's monthly Electric Progress.

Power.

Articles.

Hydraulic Station, La Goule, Switzerland. F. M. Bryan. *Elec. Wld. & Engr.* 20/5/05.
*Electrical Equipment of a Railway Shop (A. C. variable Speed Motors.) *Elec. Wld. & Engr.* 27/5/05.
Electrically Driven Printing Plant in Worcester, Mass. *Elec. Wld. & Engr.* 3/6/05.
Wheel-pits and Tunnels for Niagara Power. A. D. Adams. *Elec. Rev., N.Y.* 20/6/05.
A "White Coal" Plant, near Billegarde. A. De Courcy. *West. Electn.* 13/5/05.
Windmill Electric Plant at Askor, Denmark. *West. Electn.* 20/5/05.
Electric Power in Marble Quarries. G. E. Walsh. *Amer. Electn.* June/05.
Blast Furnace Gas Power Plant at the Tesider Iron and Steel Works. G. Hooghwinkel. *Elec. Engr.* 12/5/05.
The Use of Aluminium for Overhead Power Lines. W. B. Esson. *Electn.* 2/6/05.
*Electrically Driven Semet-Solway Coke Plant of Wigan Coal and Iron Co. *Elec. Rev.* 12/5/05.
Hydro-Electric Installation, Turbigo, Italy. E. Bignami. *Elec. Rev.* 19/5/05.
Variable Speed Motors. The Interpole Variable Speed Motor. W. Baxter, Jr. *Machy. N.Y.* June/05.
Electric Power Development in South America. *Canadian Elec. News.* May/05.

Papers.

*Series Alternating Motors for Industrial Work. C. Renshaw. *Nat. Elec. Lit. Assoc.* 7/6/05.
New Tpye Single-Phase Motor for Elevator Work. S. P. Cole. *Nat. Elec. Lit. Assoc.* 7/6/05.
Long Distance H. T. Transmission in California. G. A. Britton. *Nat. Elec. Lit. Assoc.* 7/6/05.
*The Use of Electricity in Mines. H. W. Ravenshaw. *Soc. Arts.* 22/5/05.
Modern Lightning Conductors. K. Hedges. *Soc. Arts.* 24/5/05.

Traction.

Articles.

Late Developments in Italian Electric Railways. F. C. Perkins. *West. Electn.* 20/5/05.
Storage Batteries on the Metropolitan West Side Elevated Railway, Chicago. G. M. S. Waring. *West. Electn.* 27/5/05
*Steel Under-frame Cars for the Brooklyn Rapid Transit Co. *Strt. Rly. Jrnl* 6/5/05.
*Bloomington, Pontiac, and Foliet Single-Phase Railway. G. R. Hewitt (*see* "Traction" this month). *Strt. Rly. Jrnl.* 6/5/05.
*Electricity *v.* Steam for Heavy Haulage. A. H. Armstrong. *Strt. Rly. Jrnl.* 6/5/05.
Automatic Signal and Safety Systems as applied to Electric Railways. E. Taylor. *Strt. Rly. Jrnl.* 6/5/05.
The Attitude of the Steam Roads. Dr. L. Bell. *Strt. Rly. Jrnl.* 6/5/05.
*Comparative Tests of Steam and Electric Locomotives (*see* "Traction" this month) *Strt. Rly. Jrnl.* 13/5/05.
*A Departure in Repair Shop Accounting. *Strt. Rly. Jrnl.* 20/5/05.
Worm Gearing for Railway Motors. H. Lomach. *Strt. Rly. Jrnl.* 3/6/05.
*Diagram for Recording Overhead Data. G. Tregoning. *Strt. Rly. Jrnl.* 3/6/05.
Stations of the Connecticut Railway and Lighting Co. *Amer. Electn.* June/05.
*The Single-Phase Railway System in Italy. E. A. Kerbaker. *Elec. Rev.* 2/6/05.

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High-speed Long Distance Electric Traction. C. A. Mudge. *New York Elec. Assoc.* 24/5/05.
*Electricity on Steam Railroads. C. F. Street. *West Rly. Club* May 05.
A New Automatic Point Shifter. G. P. Tierney. *Dublin I. E. E* 11/5/05.

Lighting and Heating.

Articles.

*Tests of the Tantalum Lamp. Dr. L. Bell and Prof. W. L. Puffer. *Elec. Wld. & Engr.* 3/6/05.
*The Mercury Arc Lamp and Rectifier. E. Weintraub. *Elec. Wld. & Engr.* 3/6/05.
Lighting of Railway Cars. E. L. Elliott. *Elec. Rev. N.Y.* 13/5/05.
A New Train Lighting Dynamo. *Electn.* 9/6/05.

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The Nernst Lamp. Its Present Performance and Commercial Aspect. E. R. Roberts. *Nat. Elec. Lit. Assoc.* 7/6/05.
Progress of Electric Heating. G. I. Ayer. *Nat. Elec. Lit. Assoc.* 8/6/05.
Sign and Decorative Lighting. L. R. Vredenburg. *Nat. Elec. Lit. Assoc.* 7/6/05.
Mercury Arc Rectifiers. P. D. Wagoner. *Nat. Elec. Lit. Assoc.* 7/6/05.

Telegraphy & Telephony.

Articles.

Wireless Telegraphy in Germany. A. F. Collins. *Elec. Wld. & Engr.* 27/5/05.
New Equipment of the Postal Telegraph Cable Co., Chicago. *West. Electn.* 6/5/05.

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*Efficient Lightning Protection. A. E. Dobbs.	*Sound Waves*, May/05.
Operators Efficiency and How Gained. F. B. Chester.	*Sound Waves*, May/05.
Railway Composite Systems. G. W. Wilder.	*Sound Waves*, May/05.
Telephone Subscribers Extension Circuits. H. P. Clausen.	*Sound Waves*, May/05.
*With the Signal Corps in the Philippine Islands.	*Sound Waves*, May/05.
The Question of Rapid Telegraphy. W. P. Phillips.	*Tel. Age.* 1/6/05.
*Typo-Telegraph: The Selective as against the Synchronous Principle. F. G. Swift.	*Tel. Age.* 1/6/05.
Telephone Service on Ocean Liners. F. E. Dwight.	*Telep. Mag.* May/05.
*Modern Telephony in Theory and Practice. W. H. Radcliffe	*Telep. Mag.* May/05.
The Confessions of a Telephone Girl.	*Telep. Mag.* May/05.
Study of the Telephone Giri.	*Telephony.* May/05.
*Telephone Construction Practice. H. G. Minhinnick.	*Telephony.* May/05.
Telephones in Country Houses. R. F. Kemp.	*Telephony.* May/05.
A Study of Short Distance Telephony. V. Ryan.	*Elec. Engr.* 26/5/05; 9/6/05.

Papers.

*Wireless Telegraphy Measurements. W. Duddell and J. E. Taylor.	*I.E.E.* 25/5/05.
Electromagnetic Waves. Prof. J. A. Fleming.	*Royal Inst.* 25/5/05.

Electro-Physics.

Papers.

*The Ratio of Mean Spherical and Mean Horizontal Candle Power of Incandescent Lamps. Prof. J. A. Fleming.	*Phys. Soc.* 16/6/05.
Electrical Conductivity of Flames. Dr. H. A. Wilson.	*Phys. Soc.* 16/6/05.
Contact with Dielectrics. R. Appleyard.	*Phys. Soc.* 16/6/05.
Thermo-Electric Junction as a means of Determining Lowest Temperatures. Sir J. Dewar.	*Royal Soc.* 8/6/05.
On the Magnetic Qualities of some Alloys not Containing Iron. Prof. J. A. Fleming and R. A. Hadfield.	*Royal Soc.* 8/6/05.

Central Station Practice.

Articles.

*Underground Electric Conduit System in New Orleans.	*Elec. Wld. & Engr* 13/5/05.
*Theft of Current. How to Detect, Prosecute, and Prevent. G. H. Hallberg.	*Elec. Wld. & Engr.* 13/5/05.
*The Central Station Superintendent. G. W. Hubley (*see* C. S. P. this month).	*Elec. Wld. & Engr.* 20/5/05.
Meter Testing for Small Stations. A. E. Walden (*see* C. S. P. this month).	*Elec. Wld. & Engr.* 20/5/05.
Some Points in Selecting Fan Motors. H. S. Knowlton.	*Elec. Wld. & Engr.* 20/5/05.
Some European H. T. Switchboards. I. F. Neithammer.	*Elec. Wld. & Engr.* 3/6/05.
Utilization of Exhaust Steam from Turbines. F. Koester.	*Elec. Wld. & Engr.* 3/6/05.
*The Use of White Walls in a Photometric Laboratory. E. P. Hyde.	*Elec. Wld. & Engr.* 3/6/05.
Motor Controlling Apparatus, F. W. Appleton.	*Amer. Electn.* June /05.
Separation of Moisture from Steam. R. T. Strohm.	*Amer. Electn.* June /05.
Some Things Encountered in Power Plants. W. Cavanagh.	*Amer. Electn.* June /05.
Notes on Valves. C. L. Hubbard.	*Amer. Electn.* June /05.
Extracting Oil from Exhaust. W. A. Dow.	*Amer. Electn.* June /05.
Reporting Accidents in Connection with Electric Lighting.	*Elec. Eng.* 26/5/05.
Protection of Electrical Installations against Excess Pressure Rises. Zodiac.	*Elec. Eng.* 9/6/05.
*Electricity Meters. C. H. W. Gerhardi.	*Electn.* 19, 26/5/05; 9/6/05.
*The Control of Motor Hiring Depts. of Electricity Supply Undertakings. R. C. West.	*Elec. Rev.* 12/5/05.
The Real Efficiency of Steam Boilers. W. H. Booth.	*Elec. Rev.* 26/5/05.
The Present Position of the Gas Engine. H. Allen.	*Elec. Rev.* 26/5/05.

Papers.

*Maintenance of Meters. W. J. Mowbray (*see* C. S. P. this month).	*Amer. I.E.E.* 28/4/05.
Use of Instruments on Switchboards. F. P. Cox (*see* C. S. P. this month).	*Amer. I.E.E.* 28/4/05.
Organisation of Working Forces in Large Power Houses. W. P. Hancock.	*Nat. Elec. Lt. Assoc.* 6/6/05.
The Choice of an Insulated Cable W. S. Clark.	*Nat. Elec. Lt. Assoc.* 7/6/05.
Some Investigations of Induction Losses. E. P. Dillon.	*Nat. Elec. Lt. Assoc.* 7/6/05.
Automatic Synchronising of Generators and Rotaries. P. McGahan (*see* C. S. P. this month).	*Nat. Elec. Lt. Assoc.* 6/6/05.
Operation of Transformers at Varying Frequencies. M. A. Sammett.	*Canadian Elec. Assoc.* 22/6/05.
Economy of Isolated Plants. K. L. Aitken.	*Canadian Elec. Assoc.* 22/6/05.
Carrying Capacity of Enclosed Conductors. Prof. R. B. Owens.	*Canadian Elec. Assoc.* 22/6/05.

Electrical Work in Shops.

Articles.

Repairing Field Coils. N. G. Meade.	*Machy. June* /05.
*Practical *Don'ts* for Machinists.	*Machy. June* /05.

Manufacturers.

Articles.

*A Convenient Form of Oscillograph. F. A. Laws.	*Elec. Wld. & Engr* 6/5/05.
*Calculation of Pull due to Solenoids. C. R. Underhill.	*Elec. Wld. & Engr.* 13/5/05.
*Law of the Plunger Electro-magnet. C. R. Underhill.	*Elec. Wld. & Engr.* 20/5/05.
*An Advertising Talk. G. C. Hammond.	*Elec. Wld. & Engr.* 3/6/05.
A Diagram of the Circuits of the Dynamotor. A. E. Kennelly and S. E. Whiting.	*Elec. Wld. & Engr.* 3/6/05.
Performance of Different Types of Electro-magnet. C. R. Underhill.	*Amer. Electn.* June /05.
*How to Make an Electric Buckboard. G. C. Brocksmith.	*Amer. Electn.* June /05.
Notes on the Theory and Testing of the Polyphase Induction Motor. W. Rogers.	*Elec. Eng.* 12, 19/5/05.
The Lack of Adaptation in British Trade Methods, Simplex.	*Elec. Eng.* 26/5/05.
A. C. Laboratory Testing. G. H. Rowe.	*Gnrl. Elec. Power and Gas.* May /05.
Crane Motor Testing Apparatus.	*Machy., N.Y.* June /05.

Papers.

Insulating Testing Apparatus and Methods. C. E. Skinner.	*Nat. Elec. Lt. Assoc.* 6/6/05.
H. T. Insulators, their Manufacture and Testing.	*Elec. Rev., N. Y.* 3/6/05.
The Oscillograph and its Uses. L. T. Robinson.	*Amer. I.E.E.* 28/4/05.
*Advertising Methods. P. Ingalls.	*Nat. Elec. Lt Assoc.* 7/6/05.
*Publicity as an Aid to Manufacturers. A. Warren.	*Mfgs Advert. Club, Ohio.* 9/5/05.
Armature Reaction. E. E. Brown.	*Newcastle I.E.E.* 15/5/05.

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A classified list of articles important to Manufacturers will be found in the World's Electrical Literature Section at end of Magazine.

THE WORKS AND CRANE PRODUCTS OF THOMAS BROADBENT AND SONS, LTD., HUDDERSFIELD.



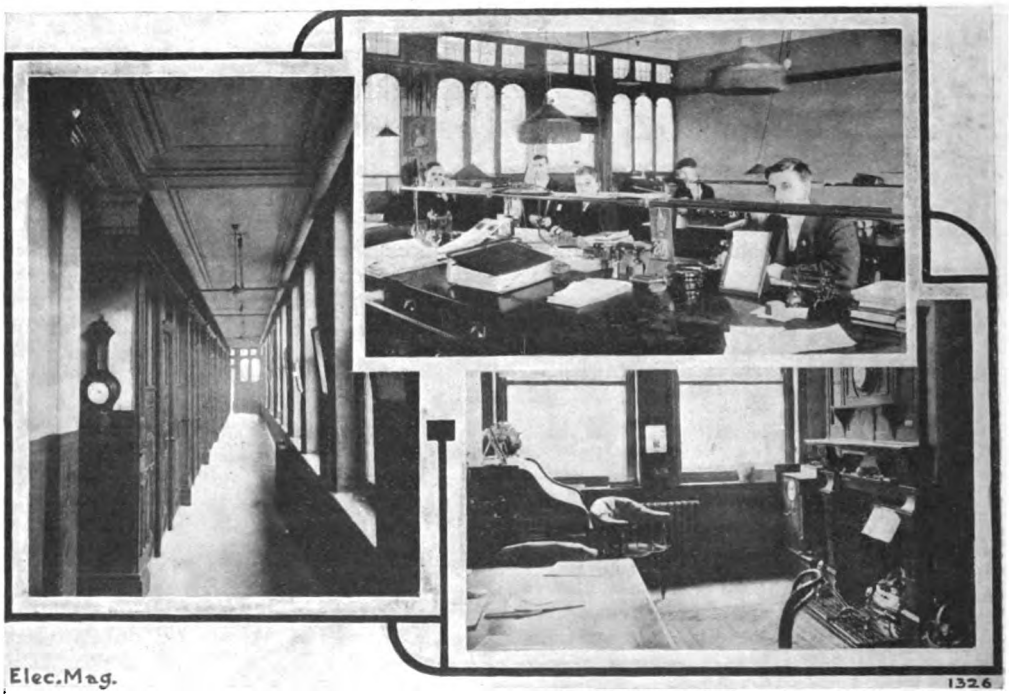
WE believe it is Anthony Hope who gives to one of his characters the capacity of "always going on." This may be said to apply equally well to Messrs. Thomas Broadbent & Sons, Ltd., who, judging by the extent to which, from time to time, but more particularly during the last two years, it has been found necessary to enlarge their works, or by the amount and character of the work turned out therefrom, have certainly won for themselves the enviable privilege of being regarded as one of the most enterprising engineering concerns in the country. At least, this was our first impression on paying a visit recently to the Central Iron Works, Huddersfield; and this impression was afterwards fully confirmed by what we ourselves saw of the manner in which Messrs. Broadbent deal with the work they have in hand. Its magnitude, the obvious thoroughness, apparent alike in great things and small, not to speak of the lively interest taken both by Mr. William Broadbent and Mr. Horace Broadbent, the two directors of the company, in all that goes on in every department of the works, all combined to strengthen our conviction of the stability of the firm. The works themselves are most admirably planned, particularly so now that the more recent additions and alterations have been completed, these including new erecting shop, foundry, machine shop, stores, offices, and dining and cloak rooms for the workmen.

In these competitive times, the principle of labour saving plays a larger part in the engineering, or, indeed, in any industry, than does the principle of philanthropy; but we were, nevertheless, pleased to notice that Messrs. Broadbent, far from forgetting the comfort and well-being of their employees, have recognised that not only is it humanitarian but that it is also policy to provide for their workmen conveniences of a material kind. These take the form of commodious dining rooms with a well-appointed cooking kitchen in which meals taken by men on the premises may be properly cooked and prepared. The men appoint their own committee for the management of details in connection with their dining rooms.

The new erecting shop, which is light and airy, is some 200ft. long by 45ft. wide, and in this commodious department are erected the cranes to which we shall refer later. The technical and commercial staff are most comfortably accommodated in a handsome suite of offices. Entering a vestibule from the street one finds an enquiry office, and also the prime cost and forwarding departments. By passing up a staircase to the first floor there is to be found a waiting room for callers, secretary's room, counting house,

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typewriting room, chief correspondent's office, the directors' rooms, and the works manager's office. All these rooms have doors opening on to a long corridor, the woodwork of which is of pitch pine. This has been specially selected, and has a beautiful grain, the panelling of the woodwork being most effective. Another staircase leads to the drawing office, plan and printing rooms. We noticed that both the commercial and technical offices are equipped with all the latest devices. The system and organisation



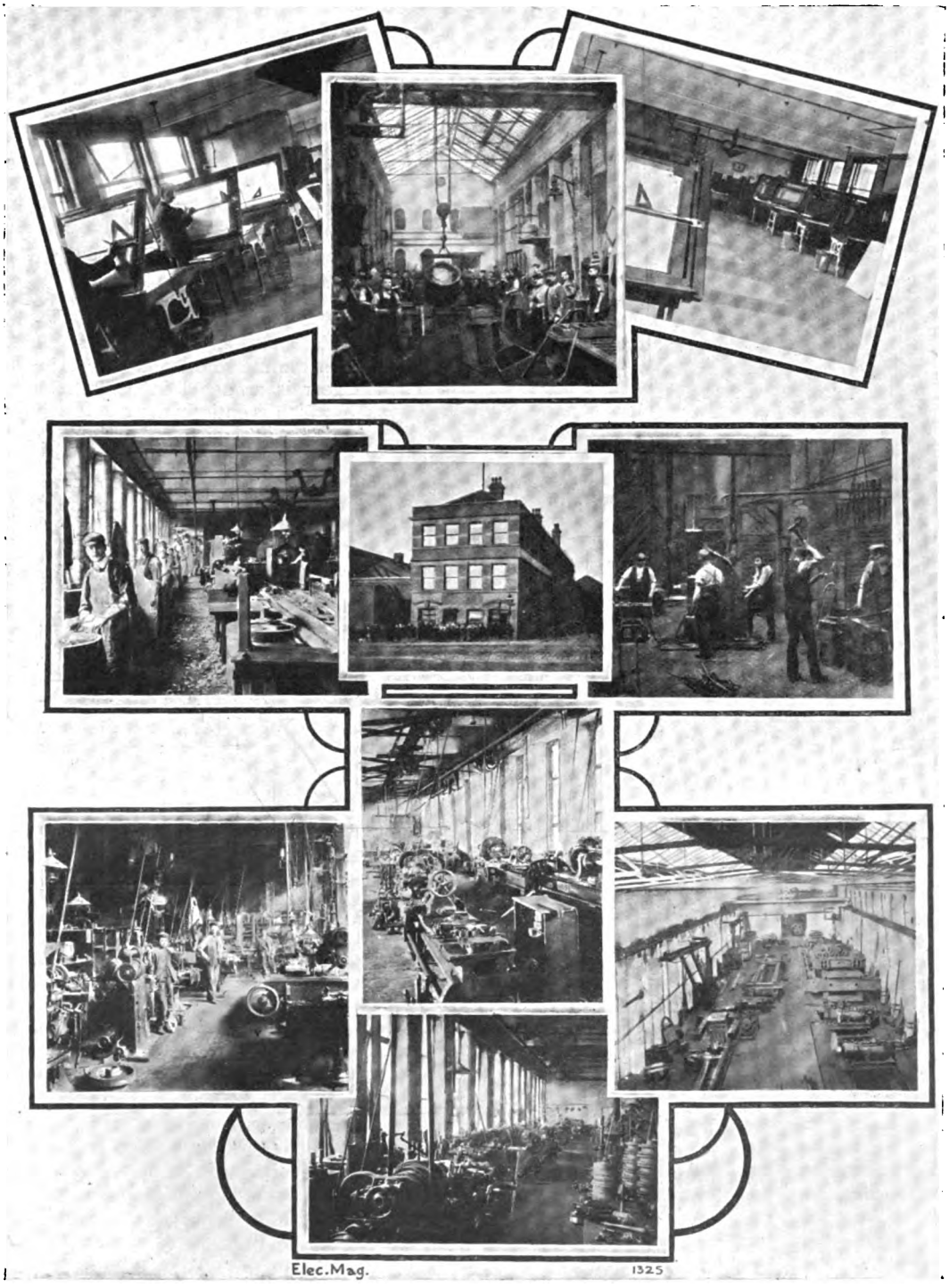
THOMAS BROADBENT'S WORKS: THE MAIN CORRIDOR, THE CLERKS' OFFICE, THE MANAGING DIRECTOR'S OFFICE.

obtaining in both departments is such as to facilitate manufacture and ensure prompt despatch of all orders. Manufacturers often experience a difficulty in knowing where to draw the line in organising, or more particularly in reorganising, and sometimes system becomes chaos and organisation a laborious clog, with the result that the last condition is worse than the first. Messrs. Broadbent, however, seem to have struck a happy medium in business methods, and put into practice a system compatible with their requirements in every way.

None of our readers need be reminded that Messrs. Broadbent have won fame as makers of hydro extractors and centrifugals, the special excellence of these machines being universally acknowledged. The firm have been associated for nigh upon forty years with the manufacture of this class of machinery; and, like the literary character to whom we referred at the outset, they have an infinite capacity for "always going on"—going on to better things and ever studiously seeking to embody in their designs everything which makes for perfection. The evolution of the hydro extractor from its crudest and most primitive form right along the line of progress to Messrs. Broadbent's latest type of electrically-driven machine would prove a most interesting study. This, however, is not part of our present object, though we might mention that such a study would be essentially also the study of the sure upward growth of the concern now under notice.

Messrs. Broadbent were very early in the field as makers of electrically-driven overhead travelling cranes. They opened out this new department in their works some

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General Views of the Engineering Shops of Thomas Broadbent & Sons, Crane Makers, Huddersfield.

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fifteen years ago, when the application of electricity to the driving of overhead travelling cranes was in its infancy. It is interesting to note that in taking this step they had no old prejudices to wipe out; they were not hampered by any rooted fondness for preconceived ideas or practices; nor did they possess existing patterns or designs which they might have felt loath to sacrifice. On the contrary, they started in right away on modern lines. We have before us at the moment of writing, a copy of the very handsome catalogue on cranes issued by the firm, in which they announce their aim to be that their crane products shall represent *all* that is best in modern crane practice. That this announcement has already been completely and undeniably substantiated, is evident from the very large number of cranes supplied, and now being supplied, to the largest and best known engineering, iron and steel works, not only in Great Britain, but also on the Continent.

To the Ebbw Vale Steel Iron & Coal Company Ltd., Ebbw Vale, Mon., Messrs. Broadbent have recently supplied what we feel quite justified in describing as a triumph in overhead travelling crane construction, namely a 100-ton six-motor ladle crane. The firm have carried out, and at the present moment have in hand, many other important contracts, but the space at our command will not permit us to describe these in detail. A brief reference to the 100-ton crane at Ebbw Vale will, however, be interesting to our readers, not only in that it is an unique crane, but also because it is thoroughly typical of the really sound work carried out at the Central Iron Works. This crane is of the double bogie type, and has a span of 45ft. between the centres of the rails along which it travels, the power being supplied by six continuous-current electric motors working at an E.M.F. of 240 volts. The crane is capable of dealing with a load of 100 tons, this being the weight of the load when a Converter is to be lifted; its normal everyday load is 35 tons.

The structure as a whole embodies many ingenious features—for instance, the relative operations of the main and auxiliary bogies, these being novel in their combination. As indicating the skill which characterises the design of this crane, it may be mentioned that the available headroom above the runway rails is only 9ft. 10½in This necessitated a considerable amount of scheming to get in girders and gear of sufficient strength, without depriving the crane of its height of lift. That this was successfully accomplished, redounds to the credit of the firm, as the headroom named is certainly very meagre for a crane of this capacity. The two main girders of the crane are of the box type, 6ft. deep, and are placed 9ft. 6in. apart from centre to centre. On the top of each girder are two lines of rails, and on these run the double wheels carrying the main bogie. This main bogie is provided with a two-speed lifting mechanism; at the slower speed 100 tons can be lifted at the rate of 8ft. per minute. The motion working the change gear is arranged in conjunction with a brake, which is entirely automatic in its action, and comes into play only when the speeds are being changed over, the gear being effectually prevented from running down.

The essential details of the crane are as follows:—

Span between centre of rails	45ft. oin.
Headroom	9ft. 10½in.
End clearance ...	1ft. 4½in.
Height of lift	52ft. oin.

SPEEDS OF MOTIONS, POWER OF MOTORS, &c.

	Tons.	Ft. per min.	Motors. Power	Motors. Speed. Revs. per min.
Main hoist	100	4	40	450
Auxiliary hoist	10	40	40	450
Light hoist	2	40	10	550
Longitudinal travel ..	—	150	40	450
Main cross travel ..	—	50	15	600
Auxiliary cross travel	—	50	10	550

The lifting medium is a heavy laminated link chain, the links and pins of which are all hardened and ground. The chain works over steel machine cut sprocket wheels, and a clever device so disposes it that when hoisting it automatically festoons instead of hanging down in one long bight. The auxiliary bogie is very ingeniously arranged to work *inside* the main girders; and, since the link chains in connection with the main bogie do not hang inside but outside the main girders, it is obvious that the two bogies can be worked quite independently of each other. Moreover, it also makes it possible to cover the space between the main girders above the auxiliary bogie with chequered steel plates, thus forming a floor the whole length of the girders.

It is the fact that either of the two bogies

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can be used quite independently of the other, or, if required, in combination with each other, which characterises the crane, and which gives to it its features of novelty and utility. The auxiliary bogie can either be used to tilt a ladle held by the main bogie, or it can be used as a ladle crane itself; in the latter event the ladle would be tilted by a 2-ton hoisting motion with which the auxiliary bogie itself is provided.

The whole structure is propelled longitudinally by a 40 h.p. motor, the movement being obtained through a cross shaft running along the entire length of the crane and gearing with the axles of the driving wheels in the end carriages.

The crane is fitted with brakes of a most efficient type, these, as well as the whole of the many different motions of the crane, being absolutely under the control of the operator seated in his cabin.

Not only is this crane a triumph in theory, but it is equally so in actual work, for, on making enquiries, we find that it is operating to the entire satisfaction of both user and maker. Messrs. Broadbent have not only displayed remarkable ingenuity in the design of the crane, but have also adhered most rigidly to the practice which characterises any work they undertake, namely, of putting into the structure only the very highest quality of workmanship and materials.

Messrs. Broadbent have in hand at present a large number of important orders for cranes, notably for the Cargo Fleet Iron Co., Ltd., Middlesbrough, Messrs. John Fowler and Co., Ltd., Leeds, Messrs. C. Akrill and Co., Ltd., West Bromwich, The Patent Shaft and Axletree Co., Ltd., Wednesbury, Sir W. G. Armstrong, Whitworth and Co., Ltd., Elswick, and many others.

As an engineering journal we at all times strive to give prominence to the superiority of British manufactures; and we have in this instance a peculiar pleasure in bringing to the notice of our readers the crane products of a thoroughly British concern.

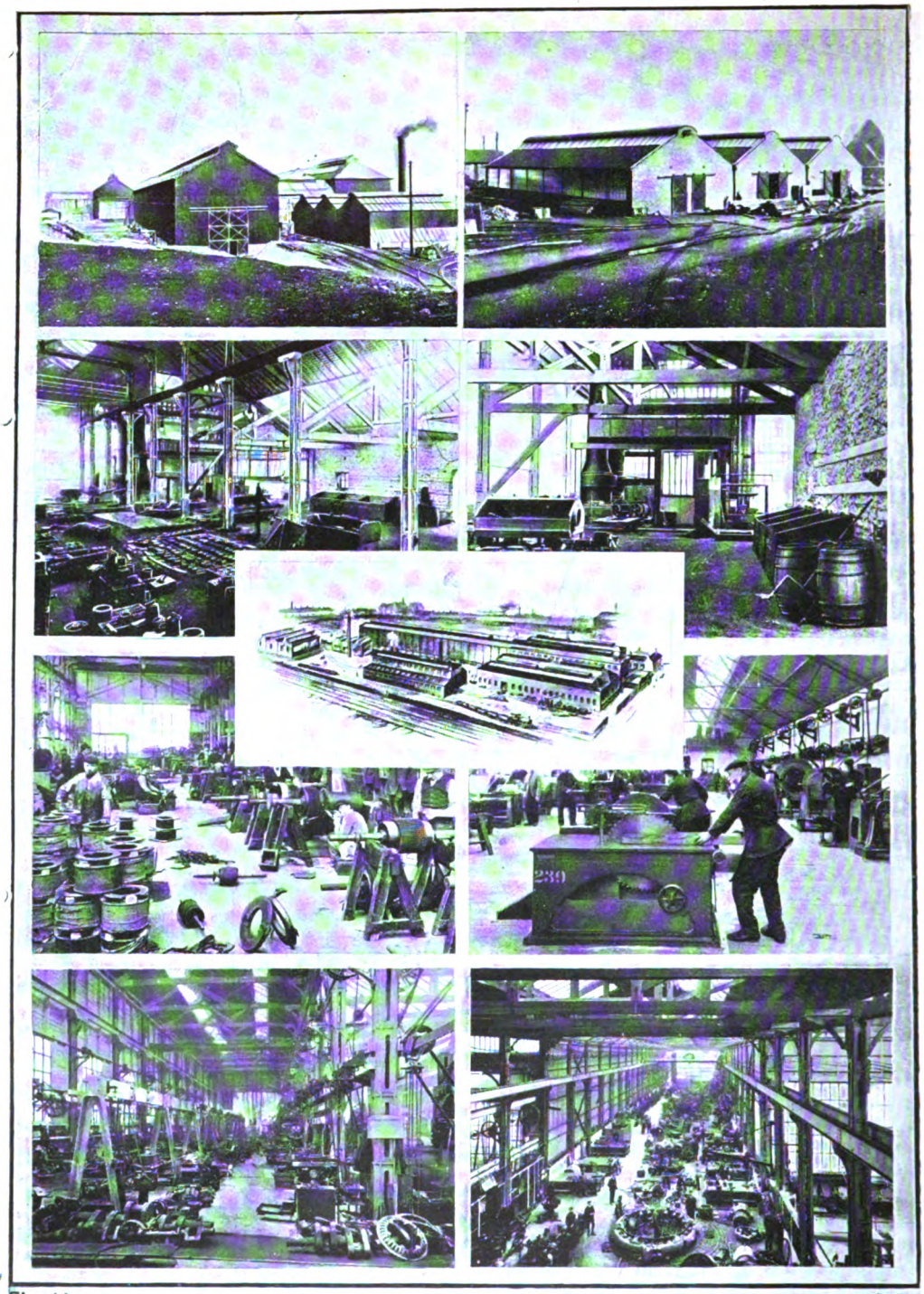
Through the courtesy of Messrs. Broadbent we are enabled to reproduce a number of photographs which we think will be of interest to our readers.

THE NEW WORKS OF MESSRS. ERNEST SCOTT AND MOUNTAIN.

LORD Armstrong, in opening the new Close Works of Messrs. Ernest Scott and Mountain, Ltd., at Gateshead, on May 21st, said in the course of his opening remarks, "The firm had shown themselves among the leaders and pioneers in this country in the utilising of electricity for the purpose of working in collieries. One often reads in the papers of how the foreigners are going forward, and especially of how Germans were trying to oust Englishmen in every part of the world, but as long as they have energy and enterprise shown in this country such as they had in the past, and the good work turned out which was being turned out at the present time, he had no fear that the Germans or anybody else would take away the reputation which had been won, or oust England from the commercial field. This eulogy of British enterprise and energy as displayed by the company in question will, we are sure, have the hearty endorsement of our readers. The name of Scott and Mountain has always been inseparably connected with electrical work in collieries. Mr. W. C. Mountain, who in quite the early days, was managing-director of the Gulcher Electrical Company, London, a modest concern compared with its modern prototypes, initiated the electrical department in 1888; and a long list of electrical pioneer installations stands to its credit since that time. To the keen foresight of Mr. Mountain, who from the outset recognised the possibilities of electric power in mining work, the success of pioneer installations in this particular province is directly due. The first contracts entered into were quickly succeeded by others of greater importance, and as a consequence the output of electrical apparatus has been continually on the increase.

As a direct outcome of this expansion the works in Newcastle have become inadequate and the extensive premises which we recently inspected have been built. The page of composite photographs which we publish gives a very good idea of the area occupied by the various shops as well as of their arrangement and equipment. The site has

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Elec. Mag. 1349

General Views of Messrs. Ernest Scott & Mountain's New Works, Gateshead-on-Tyne.

General View Looking from S.W.
Interior of Foundry.

View of Pattern Shop and Pattern Stores.
Interior of Foundry.

Bird's Eye View of Works.

Armature Shop, Winding Department.
Light Machine Shop.

Interior of Pattern Shop.
Large Erecting Shop.

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a total area of nearly seven acres, two of which are under roof. The buildings comprise comfortable offices with drafting rooms and accommodation for the staff, a large foundry, pattern shop and stores, light and heavy machine shops, taping and winding department, tool store, smith's shop and testing department. The works are electrically driven, two sources of power being available—a belt driven 120 kw. generator, and the mains of the Gateshead Electric Supply Station. About forty-two motors are used aggregating 400 h.p. The longest shop is the heavy machine shop, 558ft. long by 43ft. wide. A light machine bay adjoins this, but is somewhat shorter, though the plans allow of the erection of two further bays to the west of the present buildings. The largest machine tools are in the heavy machine bay, these comprising planers, boring mills, and lathes. The foundry contains two cupolas of the combined capacity of eleven tons per hour. The raw materials are delivered directly from the railway siding, and the blowers and loam mills are electrically operated, while the brass foundry is under the same roof. The testing department contains a complete equipment for testing high speed engines, every class of dynamo electric machine, three-throw and centri ugal pumps, &c.

The specialities of Messrs. Ernest Scott and Mountain are numerous and varied. In prime movers, steam, gas, or oil engines are constructed, the first of these being built for slow or high speed. The entire field of dynamo electric machinery is covered, and both generators and motors of every class are manufactured. The applications of these to industrial purposes are far too numerous to be mentioned here, but the experience of Messrs. Scott and Mountain covers an exceptionally wide field and places them in an unique position, in that not only can they rightly advise their clients, but also they are able to manufacture the apparatus they recommend. A few of the firm's specialities in electric hoisting gear will be found illustrated and described in the special Electrical Transport Supplement this month.

BROWETT, LINDLEY & CO.'S WORKS AND ENGINES.

MESSRS. Browett, Lindley, & Co., Ltd., of Patricroft, near Manchester, have been manufacturers of high-speed engines ever since this type of engine has been in use for electrical purposes, and are now one of the best known builders in this country. The engines built by this firm have always been of the double-acting type. In the early days, many engines were made of the enclosed type, arranged for lubricating on the splash system, but for a number of years all engines turned out by this firm have been fitted with the now well-known system of forced lubrication. The firm, after a large experience extending over many years, now build standard engines of three types, in powers ranging from 50 up to 3,000 h.p., the larger number manufactured being those of the two-crank compound type, as illustrated in Fig. 1. Engines of similar design are also manufactured in the three-crank compound and three-crank triple expansion type, but the illustration shows clearly the principle of the design of the modern Browett-Lindley standard engine. Every care has been taken in the design of this engine to make it most economical in steam consumption. The drainage of the cylinders, receivers, &c., have received most careful consideration.

As will be seen from the illustration (Fig. 2), all the motion work is generously designed, and the bearing surfaces are very large. The cylinders are each carried on a distance piece of rigid design, and with this distance piece is formed the bored guide, which is self-centering with the cylinder, now a very common practice with builders of this type of engine. All working parts are entirely enclosed, including the governor, and the engine is lubricated by oil under pressure delivered from a valveless oil pump, driven from the low-pressure eccentric. The cyclinders are lubricated by a mechanically-driven lubricator, which ensures the oil being delivered where required.

It will be evident that the only attention the Browett-Lindley engine requires is to supply it with the necessary quantity of crank chamber oil, and see that the pressure is kept up. The oil pressure is registered on a small gauge placed at the end of the

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engine, and when once adjusted, requires practically no attention for days together. The engine is controlled by a powerful governor, of the plain centrifugal type, acting directly upon the throttle valve, and by this means most perfect regulation is obtained. By the use of the speeder gear, which is noticeable above the governor, a variation of at least 5 per cent. above or below the normal speed can be obtained, but when required for special purposes a special type of speeder gear is fitted which will enable the engine to be run at speeds varying at least 50 per cent. above or below the normal. This large variation is often required for engines driving paper machinery, &c.

The high-speed engine as made to-day doubtless appears, to the uninitiated, exceedingly simple and of most elementary mechanism, and of a design which any firm of engineers could manufacture with little or no difficulty. To look at a drawing, this idea is quite natural, but high-speed engine builders have only developed a successful engine after many years of experience. The engines manufactured by Messrs. Browett, Lindley & Co., Ltd., have the highest finish possible given to them, and the workmanship is the most accurate obtainable in practice. All parts are absolutely interchangeable, and, with this end in view, are manufactured to limit gauges and micrometers, the limit of error allowed for all parts being a very small one. As in all high-class engineering works of to-day, all details manufactured are passed through an inspection department, where they are carefully measured before being put into the finished stores. If the error in any part exceeds a predetermined amount, the work is returned for alteration, or condemned as useless, as the case may be, according to circumstances.

The machinery department of this works is one of the most modern in the country, very few of the machine tools being more than three years old. A tool room, fully equipped, is also provided, also tool stores and drawing stores, all laid out on modern lines.

The works also possess a very completely equipped testing department, through which all engines are passed before being despatched. Wherever possible, the engines are coupled to the dynamos they are intended to drive, and tested under all conditions of load, but where it is not possible to have the machines at the works, or the engines are intended to drive

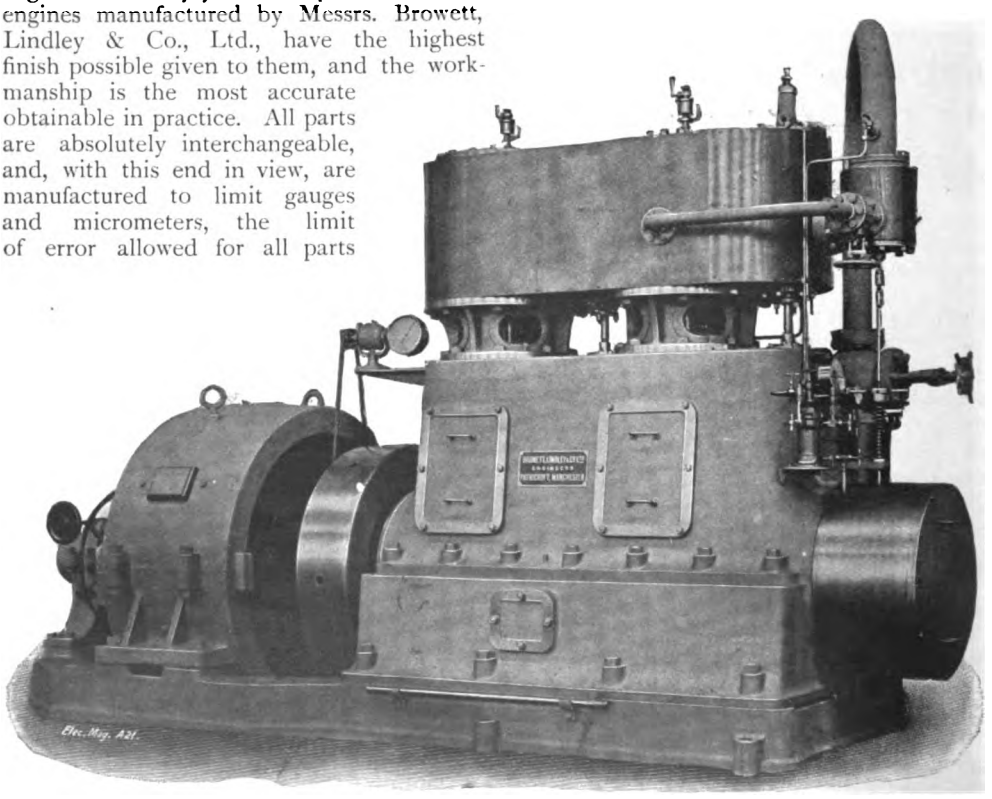


FIG. 1. BROWETT LINDLEY 350 H.P. HIGH SPEED ENGINE COUPLED DIRECT TO 200 KW. DYNAMO.

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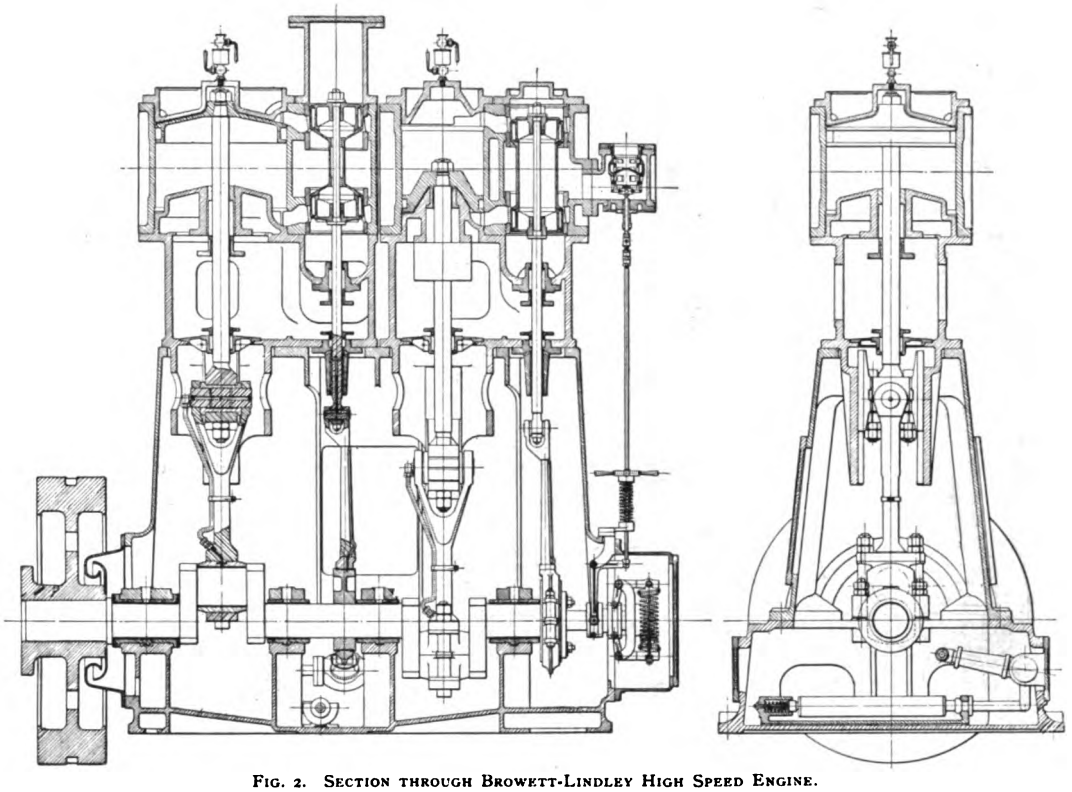


FIG. 2. SECTION THROUGH BROWETT-LINDLEY HIGH SPEED ENGINE.

by means of ropes, &c., they are coupled to a water brake and tested under full load. For this purpose the firm has two dynamometers of Messrs. Heenan and Froude's make, one capable of absorbing 700 b.h.p. at 500 revs. per minute, and a larger one capable of dealing with 1,500 b.h.p, at 250 revs. per minute. For the purpose of measuring the steam consumption of engines, a large surface condenser, with air and circulating pumps is provided, and tanks with weighing machine, &c., with all necessary appliances have been carefully arranged.

The machinery of the works is driven by a high-speed two-crank compound engine of the firm's own make, driving a large dynamo, and there is another set also kept as a stand-by. The larger machine tools are driven by separate motors, and the smaller ones are grouped and driven by motors coupled to a line shaft.

The steam plant for supplying steam to the works engines and the testing department consists of two "Climax" boilers, Morrin's patent, capable of producing about 10,500lbs. of steam per hour each, at a pressure of 250lbs. per square inch. It is thus possible to test at these works, fully loaded, engines up to 1,000 h.p.

The firm have on order at the present time a large number of engines ranging from 50 to 1500 h.p., amongst the principal of which may be mentioned the following: One 1000 h.p. triple expansion engine for Woolwich Arsenal, this being a repeat order; four two-crank compound engines for the Royal Clarence Victualling Yard, Priddy's Hard; two two-crank compound engines for the Tranmere Bay Development Co., Ltd.; one three-crank compound engine to the order of the British Westinghouse Electric Co., for the Sherwood Colliery Co., Ltd., near Mansfield; one three-crank triple expansion and a two-crank compound engine for the Newport Corporation; one two-crank compound for the Hoylake Urban District Council; one three-crank compound engine for the Keighley Corporation; and, amongst many other engines, together with condensing plants, two vertical triple expansion Corliss Mill engines, each capable of developing 1500 i.h.p.

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STAND OF LANGDON DAVIES MOTOR CO., LTD., AT PADDINGTON ELECTRICITY EXHIBITION

The Langdon-Davies Motor Co., Ltd.

THE adjoining photograph we are pleased to reproduce as illustrating the neat and attractive manner in which an exhibit of electrical apparatus can be arranged. It depicts the stand of the Langdon Davies Motor Co., Ltd., at the recent Paddington Electricity Exhibition, to which we referred last month. Although the Langdon-Davies Motor Co. has long been associated with the manufacture of single-phase motors we must remind our readers that they are makers of both direct-current and two- and three-phase motors, in addition to their special line of single-phase machines. On the extreme right of the illustration will be seen one of the former type, while the motor in the middle foreground is of the two-phase pattern.

New Catalogues.

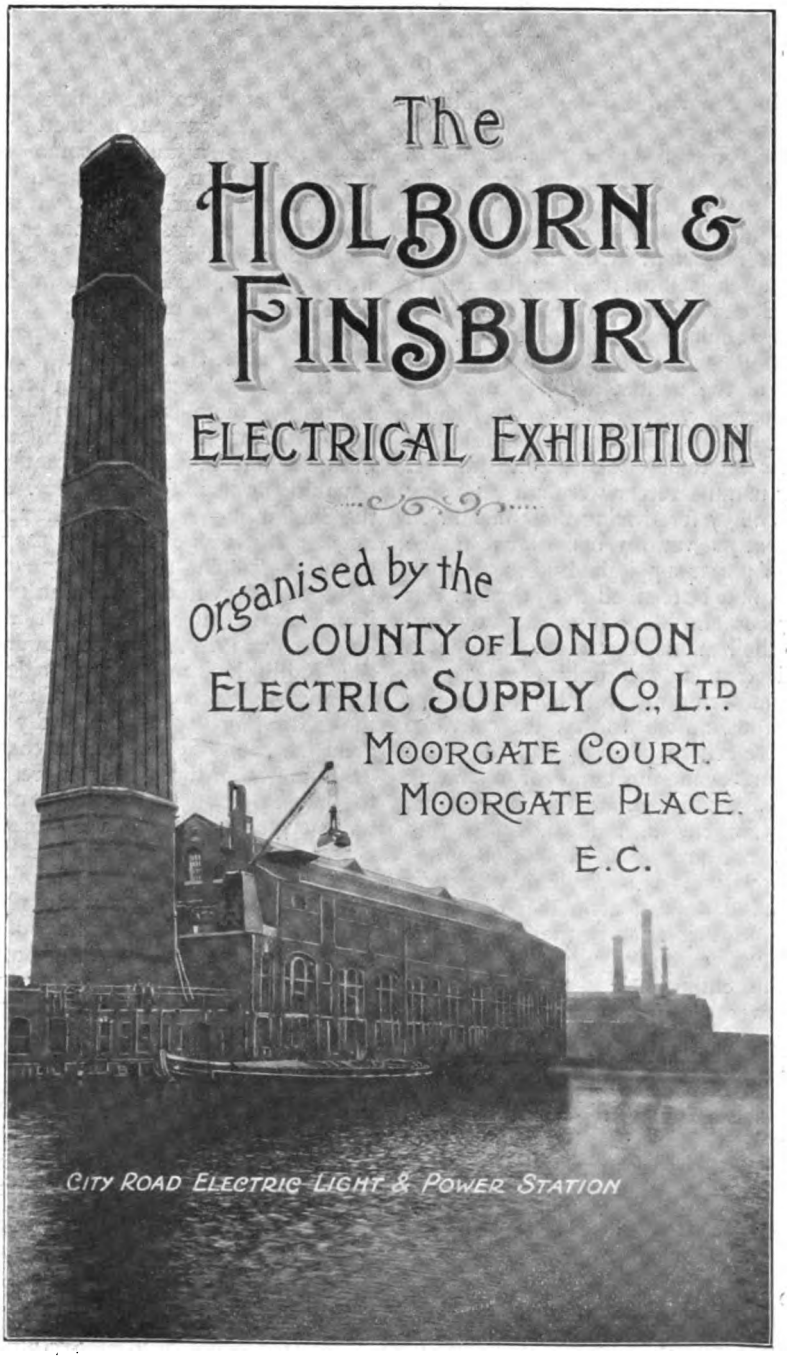
Electric Cranes. — MESSRS. THOMAS BROADBENT & SONS, LTD., Central Ironworks, Huddersfield, have just issued their Catalogue de Luxe, dealing with every class of electric crane. It is a magnificent publication, both illustrations and printing being excellent, we might almost say superb. We refer specially in this issue to Messrs. Broadbent's works and products, so will content ourselves with reminding our readers that this compilation will be forwarded at once, on request, to interested enquirers.

Electric Lift Gears.—MESSRS. SMITH & STEVENS, Queen's Road, Battersea, S.W., have forwarded a copy of their electric lift catalogue. In addition to specifying and describing their electric lift specialities it contains about twenty pages of useful data on lifts in general and electric lifts in particular. It should be in the hands, at least, of every architect.

Electric Hoisting Manchinery.—JESSOP & APPLEBY BROS., LTD., of Leicester and London, have just published a well illustrated catalogue on electric cranes and hoisting machinery of their manufacture. A very wide range is covered, from heavy electric overhead travelling cranes to the lightest of electric transporters.

Grain Handling Plant.—SPENCER & CO., LTD., Melksham. What we can only describe as a pattern catalogue is just to hand from Spencer & Co. It comprises some 170 pages, describing the conveying and elevating appliances specially manufactured for the handling of grain. The greater part of all this plant is electrically driven, and special reference to it will be found in the Transport Supplement. To this we refer our readers, but would remind them to send to Melksham for a copy of the firm's catalogue.

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The Holborn and Finsbury Electrical Exhibition.

THE Holborn and Finsbury Exhibition, which came to an end on April 5th, has been successful beyond anticipations. The attendance throughout has been maintained at a very high average, and about 50,000 visitors passed the turnstiles. An even more important point in connection with the latter is the fact that the list of visitors includes such a very great number of the leading engineers, architects, manufacturers, and others technically or commercially interested in the matter. The County of London Company, in organising the Exhibition, had in mind the increasing number of power-users on their circuits, and the fact that many manufacturers were not yet using electrical energy for driving their machines. The company's various operations in the direction of power-supply had met with such success (as may be testified to by the fact that between 7,000 and 8,000 h.p. is already connected to their mains) that the company was convinced that it was only necessary to bring the matter prominently before the eyes of the manufacturers to at once convince them that electrical energy was the most efficient and economical way of operating their plant. Throughout the districts of Holborn, Clerkenwell, and St. Lukes (the company's northern area) a special power circuit of 530 volts is run. These districts are the headquarters of a number of manufacturing industries, and the company's supply has very extensively been taken up—in fact, the enthusiastic testimony of the present power-users has fully warranted the conviction that any manufacturer who investigated the matter would at once adopt such a supply. It was to further this end that the Exhibition was embarked upon. Following this idea, all kinds of trade machinery were shown running direct from motor, and every information was given inquirers as to capital outlay and running costs. The Company notified their willingness to arrange a visit to some one or other power-installation, where the inquirer could see machinery similar to his own under actual working conditions. The power side of the Exhibition was visited by a great number of manufacturers, and the interest displayed gives every evidence that it will lead to a big extension of power-using in the immediate future. As regards the testimony of exhibitors in respect to the Exhibition, there is quite an unanimity of opinion that it will lead to an extensive business, indeed, many important transactions have already actually taken place. Altogether, the Exhibition—especially on its power side—may be taken as evidence of the very great attention which the County of London Company gives to the question of extending its power business. Although a particular emphasis was placed on the power-section of the Exhibition, the lighting side was also remarkably representative. The success of the Exhibition was undoubtedly due, in a great part, to the circumstance that the firms exhibiting were thoroughly representative of the most important branches of electrical industry, as will be seen by the following account of the exhibits. A further factor contributing to the success of the Exhibition was that the very large areas supplied by the Company increased the number of interested parties very considerably. The Southern district alone includes some twenty-two square miles, and here, the Company carry on their extensive operations in wiring small houses under the slot-meter system, and larger ones under the rental system or hire-purchase. Specimens of their undertakings in this way were shown at the Exhibition, in the shape of model-cottage rooms, and a suite of first-class drawing and dining rooms.

We take this opportunity of announcing our intention of publishing, next month, a Special Supplement dealing with the Electrical Exhibition recently held in Paddington Baths, under the auspices of the Metropolitan Electric Supply Co., Ltd. Full details of the chief Electrical Exhibits will be given.

Exceptional opportunity for exhibitors to advertise. They should apply or write for special terms.

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THE COUNTY OF LONDON ELECTRIC SUPPLY COMPANY, LIMITED.

THE County of London Electric Supply Company is one of the largest of the London Companies, as regards area of supply. In the case of the Southern district alone, this amounts to more than twenty-two square miles. To this must be added its Northern area, consisting of the districts of Clerkenwell, Holborn and St. Luke's. The Northern and Southern areas are at present isolated from each other, and supplied each from its own generating station. In the Northern area, the Central Station is in City Road. In the Southern area, at Wandsworth. The system of distribution is of particular interest. The Southern district consists of the Borough of Wandsworth (including Wandsworth, Putney, Roehampton, Clapham, Streatham, Balham, and Tooting), the Borough of Camberwell and the parishes of St. George the Martyr, Southwark, and St. Olave, Bermondsey. To the outlying portion, the distance from the Wandsworth generating station is as much as ten miles. The distribution is effected from five sub-stations (Wandsworth, Streatham, Clapham, Camberwell, and St. Olaves). From the first centre the distributors are worked at 2.000 volt pressure. In the case of the other four sub-stations, two phase current is transmitted at 6,000 volts, and transformed at the sub-stations to 2,000 volts for distribution. In the St. Olave's district this is further transformed to continuous current at 205-410 volts. The secondary distribution is dealt with by 2,000 volt cables radiating to the transformer boxes, where the pressure is lowered to 205 volts, or 205-410 volts. All transformer chambers are interconnected, so that a second route is available for supply in case of accident. In the Northern area the current is generated at 2,000 volts, and transformed into 104 volts. A special power circuit of 530 continuous volts is also run in these districts. As regards the Company's policy, this is decidedly a progressive one, and it is a recognised fact that the Canvassing Department is second to none in the Kingdom. The company is prepared to arrange for either power or lighting installations, to be carried out free of initial cost to the consumer, and in special cases motors are installed for a period of 3 months on free trial. Lighting installations can be provided either under a hire-purchase, rental-wiring, or prepayment-meter system. A very large number of installations have been carried out by the Company under the various systems which have become very popular indeed. The big L. C. C. estate at Totterdown, Tooting, will be lighted throughout by the Company, under their slot-meter system. A large number of flats also, of which there are very many on the Company's areas, are lighted on this system. For better class houses, the rental-wiring scheme has been arranged by which the consumer pays 4½d. per lamp per quarter for each lamp installed. Where the tenant owns the house, the hire-purchase system is generally preferred, in which case the payment is spread over a period of years to suit the convenience of the consumer.

As regards general rates, consumers can choose either the maximum demand system or a flat rate. Subject also to the consumers entering into an agreement for a period of years, the Company, when justified by the character of the demand, is prepared to grant reduced rates. A low rate of 3d. is also granted for basement lighting. For power and heating, the rate is 2½d. per unit, but this is subject to a sliding scale of discounts down to 30 per cent., and the scale is further extended where justified by the character of the demand. The power-side of the Company's operations have been very successful indeed, and applications have been received for over 8,000 h.p. Prospective consumers are given every opportunity of investigating the matter of the use of electrical energy for motive purposes, and the County of London Company are always open to afford them an opportunity of seeing practically any class of machinery at work in their power circuits, and also to give full information regarding the efficiency and low running costs of such installations. The Secretary of the Company is Mr. H. B. Renwick, and the Chief Engineer Mr. C. P. Sparks, M.I.C.E.

As an illustration of the Company's enterprise in developing its Power business, we may take the Cold Storage Wharves, in Tooley Street. In the plant shown in illustration, there are two 55-h.p. motors driving the ammonia compressors. The actual putting in of this electrical plant is a very good

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The County of London Electric Supply Company, Ltd.,

supplies energy for Lighting, Power, and Heating in the following

AREAS OF SUPPLY.

BOROUGH OF FINSBURY.
BOROUGH of HOLBORN (part of).
BOROUGH OF CAMBERWELL.
ST. GEORGE THE MARTYR, SOUTHWARK.
BOROUGH OF WANDSWORTH, including Wandsworth, Putney, Roehampton, Clapham, Streatham, Balham, and Tooting.
ST. OLAVE, BERMONDSEY.

POWER AND HEATING SUPPLY.

Current for Power and Heating purposes is supplied by the County of London Electric Supply Company, Limited, at **2½d. per Unit,** with Discounts in respect of accounts exceeding £5 per quarter.

The Company is also prepared to supply Electric Cranes, Lifts, Luffing Cranes and Motors of any type on the **Hire-Purchase or Rental Systems.**

Intending Consumers desiring further information are invited to communicate with the Secretary at the Head Office of the Company, where full particulars regarding the running costs of Motors for driving any type of machinery can be obtained.

LIGHTING SUPPLY.

The Company is prepared to arrange for Installing Consumers' Premises on any of the following Systems:—

HIRE PURCHASE.

Under this system the Installation is carried out by the Consumer's Contractor, the repayment being spread over a period of years to suit the convenience of the consumer.

RENTAL WIRING.

Under this system Consumer's premises are wired and fitted with plain fittings, FREE OF INITIAL COST to the occupier, on payment of a rental from 4½d. per quarter per lamp installed.

PREPAYMENT METERS.

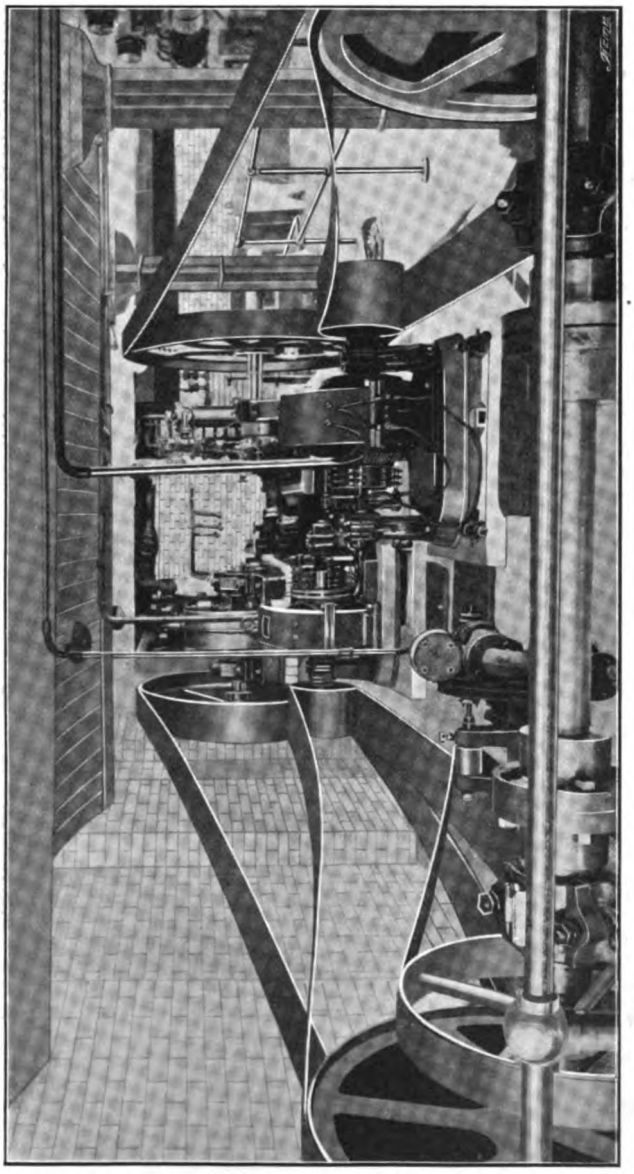
For small premises, held on short tenancies, Current can be supplied through a Prepayment Meter (Slot Meter) at an inclusive price covering the cost of Wiring, Fittings, and Rent of Meter.

For full particulars apply to the Secretary of the Company at the Head Offices,

MOORGATE COURT, MOORGATE PLACE, E.C.

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illustration of the despatch with which an important matter is put through by the Company. The compressors were originally driven by an 80-h.p. gas engine, which broke down one morning and required dismantling.



TWO 55-H.P. MOTORS DRIVING AMMONIA AIR COMPRESSORS.

Owing to the nature of the business, time was of importance, as perishable stock, amounting to several thousand pounds, was involved.

The mains were carried in by the Company the same afternoon, and electric motors were installed and in full working in a day and a half, in place of the gas engine, and the stock secured from injury.

This, however, is an example of merely one type of machinery run off the Company's main. But in one part or other of their extensive areas, there could be seen almost every type of machine, motor driven. In Holborn and Clerkenwell especially, the power-user predominates. A very large number of printing firms are now exclusively using motors for their presses, in fact, in this trade there can be seen some of the best examples of the efficiency and low running-costs of motors when used on extensive installations.

Another branch of power-use, where the advantages of the use of electric energy is, perhaps, the most obviously apparent, is in connection with hoisting gear. It does not matter whether this be in the way of heavy crane-work or in the lighter gear for lifting and transporting merely a ton or so or under. In every case the advantages of motor-driven plant are so obvious that it needs only investigation on the part of users of this kind of machinery to at once convince them of the advisability of adopting this method of driving. The running costs are, in fact, absurdly low, and the company are in a position to give actual figures as obtained in works which they can give the enquirer an opportunity of visiting.

For lighter work, such as goes on in the clock-making trade, the headquarters of which industry lies in the Company's area of Clerkenwell, the use of motors is very advantageous indeed, especially in trades like these, where space and absence of vibration are of importance.

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THE HEN

THAT LAYS THE

GOLDEN EGGS.

Send a Post-card for further information.

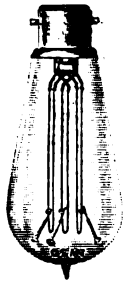


Head Office: 71, QUEEN VICTORIA STREET, LONDON, E.C.

Telegrams: "Electricity," London. **Telephone: 887 Bank** (6 Lines).

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THE EXHIBIT OF THE GENERAL ELECTRIC CO., LTD.



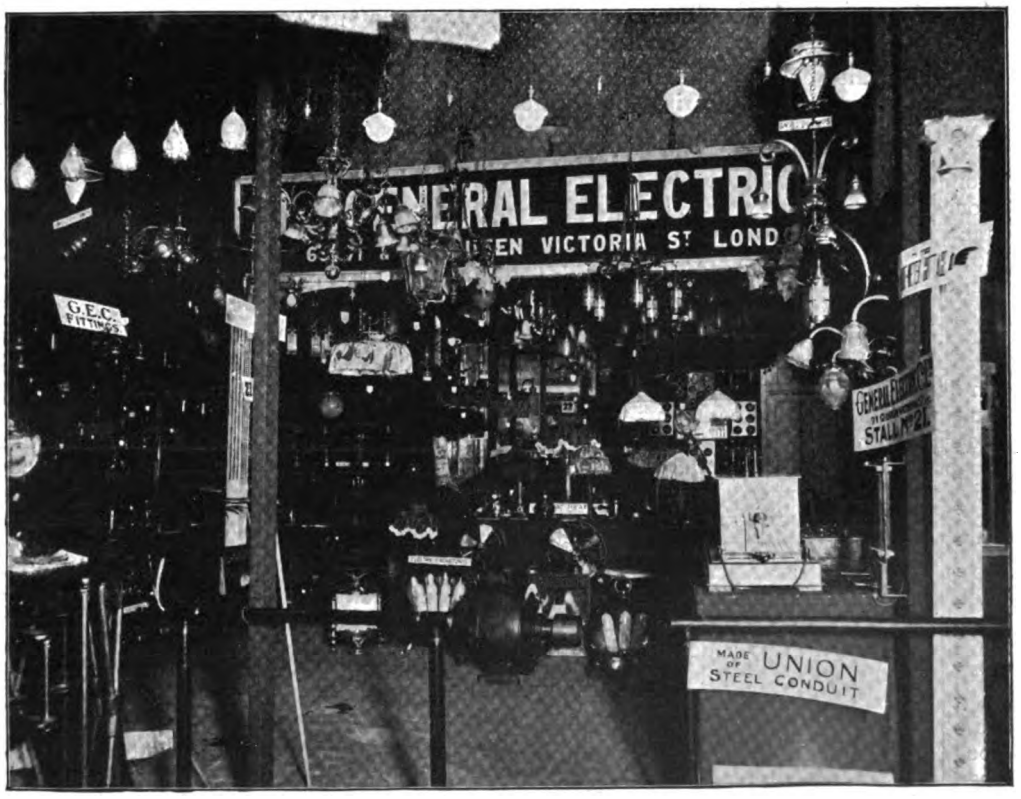
THE "OSMI" LAMP.

A VERY prominent position was that occupied by the General Electric Co., Ltd., of 71, Queen Victoria Street, and their exhibit comprised motors, meters, telephones, and bells of every description, heating and cooking apparatus, and a splendid assortment of electric light fittings.

On this stand were also shown examples of British made carbons for the manufacture of which this company has become noted. Another interesting feature of the exhibit which attracted considerable attention was the stall whereon was shown roughly the manufacture of the well-known "Robertson" lamp.

Among the general display of electroliers, pendants, &c., one was attracted by the particularly brilliant light given out by the "Osmi" lamps with which some of these fittings were arranged. The "Osmi" lamp is entirely new, and is destined to take an important part in interior lighting in the future. This lamp is more expensive than the ordinary, but being of exceedingly high efficiency, viz., 1½ watts per candle, is continually saving money every hour that it is giving out light, and this in itself is a more important item than the initial cost of the lamp. The filament is constructed from the rare metal osmium.

Whilst on this question of lighting, mention might be made of the Robertson "Wytelite" lamp, particulars of which were given in a very interesting little pamphlet which was being distributed. This is also a high efficiency lamp with a very large bulb, so arranged to give a perfectly white light with a total absence of shadows. The general



VIEW OF CORNER OF STAND OF GENERAL ELECTRIC CO., LTD.

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effect of these lamps is very pleasing, and will be found particularly suitable for showrooms, etc.

The display of Aron electricity meters and electric clocks was a good exhibit in itself, the former attracting the attention more especially of Central Station engineers, who were much interested in the portable and traction types. Great improvements have been made in these meters, and the general arrangement and superior finish of the mechanism leaves little to be desired.

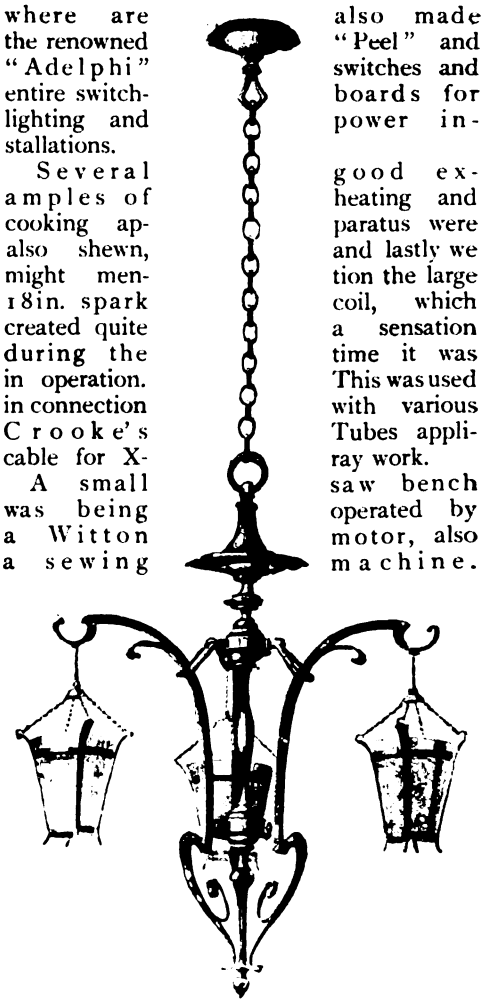
The Aron electricity meter is particularly suitable for the measurement of unsteady loads, as it requires no starting current and its measuring parts are in continual motion. The meter is made in three different forms —the switchboard instrument, the traction instrument, and the portable standard instrument; the latter is used for satisfactorily checking the accuracy of consumers' meters *in situ*.

Mention must also be made of the induction motor meter recently manufactured by the Aron Meter Co. This meter is wonderfully compact, and has been specially designed for alternating current curcuits. The counting gear is neither of the ordinary dial order with moving hand, nor is it a cyclometer train, though it resembles the latter more than the former, having all its advantages and none of its disadvantages. With the Aron counting gear it is impossible to make a mistake in the reading, as each figure is securely locked in its place behind its dial opening until such time as it is necessary for it to move to make way for the next higher numeral, when it instantaneously springs forward, and the next numeral is then locked in its place. The disc is of aluminium, and runs upon hardened steel pivots in jewelled bearings; the shunt and series windings are so proportioned and relatively placed as to give a strong driving torque with small C.R. losses. The makers guarantee that this motor meter will start with a current equal to 1 per cent. of full load. We would advise our readers to procure, if they have not already done so, a copy of the special pamphlet which gives a description of this new type of meter.

The General Electric Co. have long been famous as manufacturers of telephones and bells, and a most interesting exhibit of these particular and most useful pieces of apparatus was to be seen on their stand. All of these are turned out at the Manchester works, where are also made the renowned "Peel" and "Adelphi" switches and entire switchboards for lighting and power installations.

Several good examples of heating and cooking apparatus were also shewn, and lastly we might mention the large 18in. spark coil, which created quite a sensation during the time it was in operation. This was used in connection with various Crooke's Tubes appliances for X-ray work.

A small saw bench was being operated by a Witton motor, also a sewing machine.



TYPICAL 3-LIGHT FITTING (G. E. C.).

Several types of these motors were shown, together with various starters and speed regulators.

The General Electric Co. have quite an extensive department devoted to electro-medical apparatus, to which it is constantly making additions to keep it right up to date.

The stand was railed off with a barrier made from the Co.'s "Union" conduit. It is impossible to do justice to the various and splendid types of electric light fittings which this Company manufacture at their Birmingham works in the space allotted to this notice, and readers are recommended to pay a visit to their extensive showrooms at 67 and 69, Queen Victoria Street.

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THE EXHIBIT OF PENROSE & CO.'S LIFTS AND HOISTS.

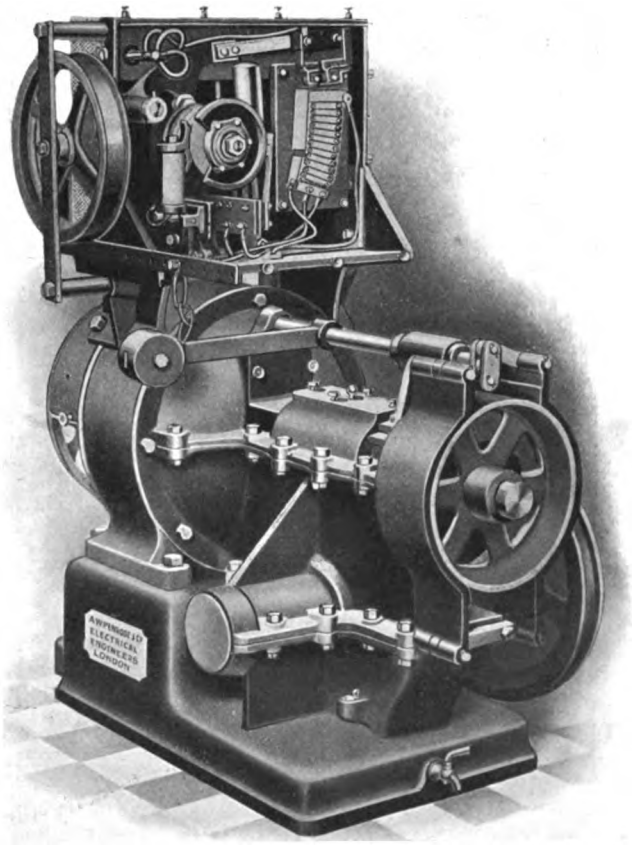
A visit to the very interesting exhibit of Messrs. Penrose and Co., 109, Farringdon Road, E.C., recalled the gossip we had heard in several directions of the rapid growth and increasing popularity of this firm's specialities in the way of Electric Lifts and Hoists. Commencing with their experience gained by the first lift installed by them, they realised that buying a motor here, a controller there, and a reducing gear somewhere else, and erecting same on the customer's premises was attended by results which left much to be desired.

For many months no further outside work was attempted ; but busy brains were at work all the time thinking out, planning and making drawings of a complete motor, gear, and controller, intended to remedy the faults and failings experience had revealed.

As a result of this care and thought, their goods equipment was evolved and gradually improved until it has now become their standard set for warehouse work up to half a ton capacity. Briefly, the following is a description of the latter. The motor is a specially designed series, one of 5 h.p. of low speed. The Motor case forming the magnet yoke is of steel, making a very small motor in appearance. The reduction is obtained by a combination of worm and spur gearing. Superimposed above the motor, and bolted on to the latter, is the controller, which is of the horizontal tramway type, and is actuated by the handrope wheel. The movements are quite automatic, and we must say that the absence of sparking even on 530 volts was very remarkable. The general appearance is very neat and extremely compact, the floor space occupied being only some 2ft. 4in. by 1ft. 8in. Being a series motor it is capable of standing a very considerable overload, in fact the first equipment made has now been running with hardly a single hitch, though constantly overloaded by about 50 per cent. in a busy warehouse.

Having mastered the difficulties of the goods Lifts, the firm now turned their attention to Passenger Lifts. Gradually a design has been evolved which as embodied in those we have seen, would, we think, be very difficult to improve upon, both for mechanical and electrical efficiency. No expense has been spared in producing a standard design capable of prolonged wear and tear, and requiring but little skilled attention.

The motor is wound so that on taking up



Penrose Electric Lift Gear.

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its load, it runs as a compound one. By an ingenious arrangement on the controller, when the arm has travelled over a certain distance of the contact pieces, the series windings are cut out, and the motor runs as a shunt wound one. The worm gearing, which is of mild steel and cut from the solid, is continued without any coupling, and forms the armature shaft. The end thrust is taken up by ball bearings, and the gear wheel which is placed under the worm is of phosphor bronze. In the case of the hand-rope controller, the latter, as in the case of goods equipment, is bolted on to the top of the motor, and the whole makes an extremely compact set which can be placed at the top or bottom of the lift-well the floor space required by the bedplate being only 2ft. 6in. by 1ft. 8in., for the 10cwt. size. The illustration is intended to convey an idea of how compact is the motor and gearing. Messrs. Penrose and Co. are firm believers in V-grooved sheaves, in preference to the winding drum method of driving. They claim that in the former system, should the limit switches fail, and the car ascend or descend either the latter or the balance weights, as the case may be, come to rest on the stops provided, and the tension being to some extent taken off the cables the motor continues revolving without injury.

Great care and thought has been expended in making a thoroughly reliable safety gear, which comes into operation if any one of the cables stretches unduly, or if one or more of the ropes break. The writer was present on two occasions when this gearing was tested. The suspending ropes were cut through, and in each case the drop of the car, although containing 7cwt., was only an inch and a half.

Having got over the difficulties attendant upon hand control, attention was next given to that of the switch-in-cage pattern, and with most satisfactory results. We should have liked to have given full details of this ingenious device, but space will not permit of more than a brief description.

The controller itself is mounted on a slate panel, behind which is the resistance box. It consists of a solenoid controlled Rheostat, four solenoid switches, a "no load" and "overload" release. All these are governed by the car switch, which is of neat design, with a self-centreing handle. To make the car ascend the latter is pressed forward; to descend it is pulled backwards. So long as it is held in the one or the other position the car will continue to travel, but directly it is let go the car stops instantly, the handle flying back to the centre or "off" position. The car switch being actuated by a shunt circuit only, no trouble can possibly arise from "arcing," the current being so small. The movement of the car switch from the centre first excites two of the four solenoids causing them to close their switches, and so determining the direction. The speed at which the resistances are cut out is regulated by a dashpot, and this can be adjusted as required. The brake is a magnetic one, and is quite automatic, and of the balanced type. In this, as in other types of Messrs. Penrose and Co.'s electrically-controlled hoisting gears, the aim has been to make them so automatic and so simple as to be practically "fool proof" whilst capable of being worked by even the most inexperienced attendant. So far as we can judge they have certainly succeeded in this respect, What struck us as being remarkable was the extremely smooth starting and stopping effected by the switch-in-cage, while the gliding movement, both in ascending and descending, was more like that obtained by hydraulic power than power transmitted through mechanical gearing. As regards the efficiency of their lifts, Messrs. Penrose and Co. have some really remarkable figures to offer, figures which should certainly at once convince any building owner as to the form of power lift to install.

Basing their calculations on the assumption that an ordinary goods lift makes some fifty journeys a day for three hundred days in the year and carrying, say, 10 cwt., they will guarantee that such a lift will make 15,000 double journeys for the sum of £2, paying 2d. per unit for current.

A careful record taken of a busy city lift showed that it made 30,000 double journeys at an actual cost of £13 4s. 10d., while the cost of repairs amounted only to a few shillings for new brushes for the motor.

In another test on a 1-ton lift in a City warehouse the following results were obtained with a load of 20cwt :—Going up = 5·75 h.p.; coming down = ·35 h.p.; therefore average = 3 h.p. One single journey of 80 feet is completed in one minute. Current taken at 2·5d. per unit, the average cost per journey = 1d. Number of complete double journeys up and down = 5 for 1d.

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Code:—5th Edition, "A.B.C."

J. G. CHILDS & CO.,

LTD.,

Hawthorn Road,
WILLESDEN GREEN, LONDON, N.W.

Electric Lifts, Hoists, Cranes,

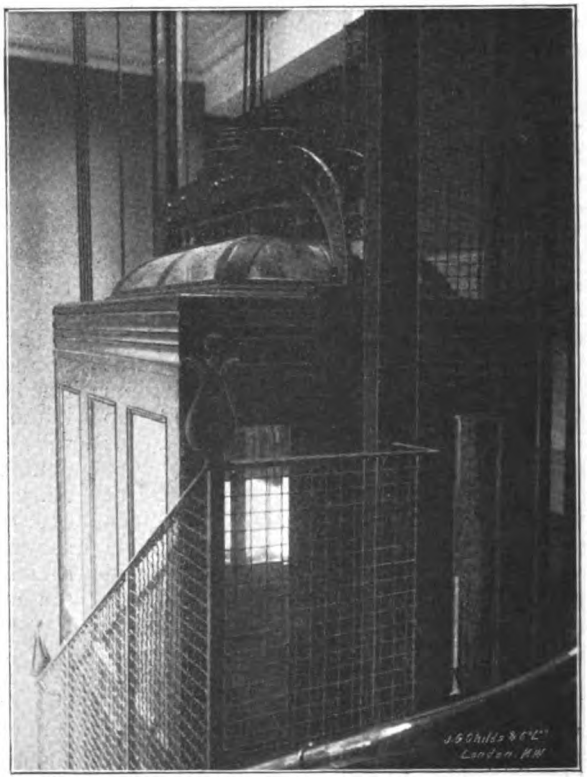
Etc.

Specialists in all Electric Hoisting Apparatus.

Push-Button Control.

Direct Connected Alternating Current Lifts.

Fast Speed Push-Button Service Lifts.



PASSENGER LIFT BETWEEN FLOORS.

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THE EXHIBIT OF J. G. CHILDS & CO., LTD.

ELECTRIC power is rapidly displacing hydraulic power for the operation of lifts, hoists, and conveyers. A splendid example of what can be done in this direction was on view on the stand of Messrs. J. G. Childs and Co., Ltd., of Willesden Green, N.W., and being a working exhibit it attracted considerable attention. A speciality of lifting appliances has been made by this firm and a number of interesting designs have been standardised. We illustrate three of these as typical of the Company's manufactures. Fig. 1 shows a service and dinner lift operated on the push button system and having a capacity varying from 10 to 300 lbs. The lift is operated from three push buttons, a set of which is placed on every floor. We understand that a large number of these lifts are in use and they can be operated at a cost of only a few pence per week. Fig. 2 shows a half-ton electric jib crane specially adapted for use in warehouses and on wharves. A strong crane type electric gear is fixed in a convenient position for the operation of the crane. Cranes of this class are built for all loads. A five-ton electric travelling crane is shown in Fig. 3. The three motions of travelling, traversing, and hoisting are affected by independent motors which are controlled from a suitable cabin at one end of the girders. Current is collected from trolley wires carried along the crane gantry. The firm has also a line of passenger lifts and hoists and conveyers for produce of all kinds. A number of automatic hoists have been fitted in cold stores, warehouses, and distilleries. One particular form is capable of dealing with 300 quarters of beef per hour, raised to a height of 50ft. at an average working cost of 2½d. per 100 quarters, with current at 2½d. per unit. A lift gear is also supplied fitted with a one-phase motor, the feature of the gear being that it can start under full load, and will start, stop, and reverse as readily and with the same reliability as a direct current gear. A typical conveyer has been installed at the Southampton Cold Storage and Lairage, which has a capacity of hoisting 2000 sheep per hour. It also handles beef, mutton, boxes of Continental egg cases, sacks, and barrels. The latter each weighing 150lb. are raised to the top floor of the building, under guarantee of the manufacturers, at not less than 1½d. per hundred.

In the same establishment a band conveyer is installed to carry produce into the basement, but it is also used for removing goods. It comprises a broad endless belt, about 5ft. wide, passing over two drums, one at each extremity, and supported by smaller drums placed under the top side of the belt at intervals of about 12in. apart. This band conveyer will handle almost anything, and at a working speed which can be varied within a range of about 50 per cent. Egg cases, each weighing about 2 cwt., can be handled at the rate of 600 per hour. A speciality is also made of passenger and goods lifts, both

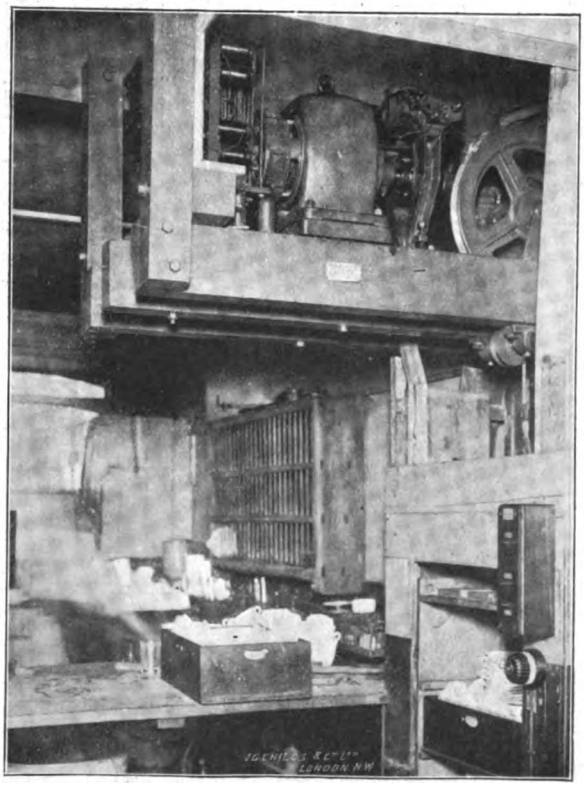


FIG. 1.—PUSH BUTTON ELECTRIC DINNER LIFT.

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types of which can be built for any required speed. The car or cage can be controlled by rope, switch, or push buttons as desired. With these lifts, a load of one ton can be raised to a height of thirty-five feet, at a cost of 1/12th, of a penny per journey. Powerful brakes are fitted, which immediately come into action directly current is cut off. An over-wind Switch is also provided, which is quite positive in action, and never fails to operate. All working parts are generously proportioned, thus ensuring ample strength. The worm-wheels are made with a massive cast-iron centre and phosphor bronze rim, special care being taken with this very important part of the gearing. Messrs. J. G. Childs & Co. have specialised in this particular branch of electrical work for a number of years, and are prepared to cater for every type and requirement of conveying and hoisting plant. The value of the electromotor has been fully realised by them, and every attention is paid to the details for hoisting purposes, etc. The extreme simplicity and beauty of the push-button method of control particularly commends itself to those requiring the safe, speedy, and efficient transport of any articles of commerce. The system permits of the production of a combination which is absolutely fool proof, all the operations being automatically performed, though at the same time the apparatus is perfectly under control.

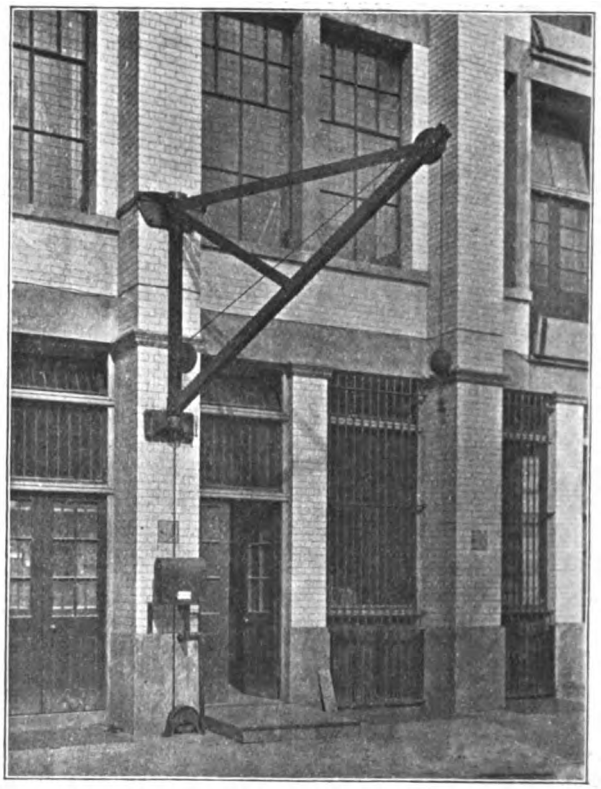


FIG. 2.—½-TON ELECTRIC JIB CRANE FOR WAREHOUSE.



FIG. 3.—5-TON ELECTRIC TRAVELLING CRANE.

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BABCOCK AND WILCOX EXHIBIT.

AN extensive space was occupied by Messrs. Babcock and Wilcox, Ltd., at the foot of the stairs in the basement. Models of the famous boiler and chain grate stoker were on view, and a description of the former will be of interest.

The boiler is composed of a number of sections, each consisting of several tubes, expanded at each end into staggered headers, or "uptakes" and "downtakes." The headers are provided with handholes placed opposite the end of each tube, to permit of the cleaning, or, in case of need, the removal of a tube, each handhole being provided with a cap, fastened with a wrought-steel bolt and clamp, and a cap nut. The top ends of each section are connected to a steam and water drum of ample capacity, the sections are inclined, and, at their lowest point, are each joined to a mud drum. The boiler is fitted with the usual mountings, comprising main steam stop valve, safety valve, feed valve, blow-off valve, water gauges, and steam pressure gauge. The entire boiler, with the exception of the furnace, is suspended by wrought-iron slings from iron girders resting on wrought-iron columns, so that the boiler can expand or contract without any strain being thrown on the brickwork. The boiler and furnace are enclosed in masonry lined with firebrick, the furnace being arranged below the tubes, and firebrick baffles compel the hot gases to pass upwards, then downwards, then upwards again, before escaping to the chimney.

The damper for regulating the draught and flow of the gases is placed in the back chamber, whilst doors for cleaning the tubes and removing soot are placed on one side of the brickwork. The principal elements in the construction of the boiler are essentially comprised of three parts, each connected with the other, and in each of which the process of steam-raising is separately carried on.

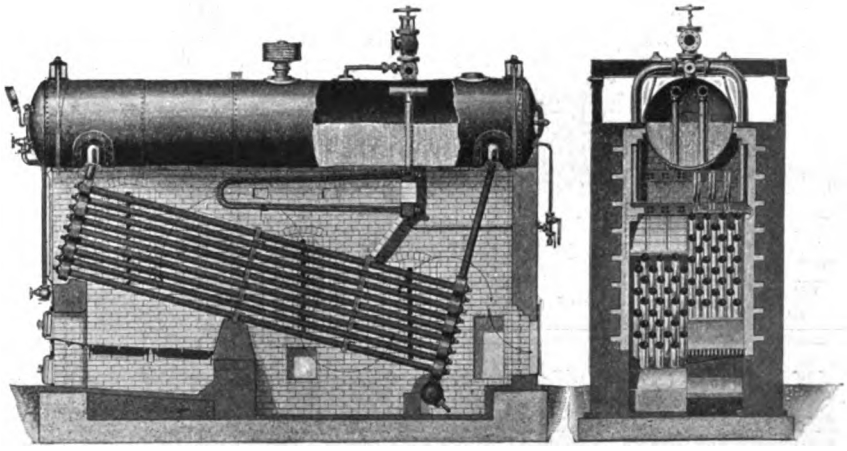
1st. A Series of Inclined Water Tubes over the furnace, in which the water, being divided into small volumes, is quickly raised to a high temperature, and rises through vertical connecting boxes or headers at the front end into—

2nd. A Horizontal Steam and Water Drum, where the steam separates from the water. The water remaining returns through the vertical tubes at the back into the inclined water tubes, where it is subjected to the action of the fire, and again passes into the steam and water drum.

3rd. A Mud Collector, attached to the lowest point of the inclined water tubes, into which any matter held in suspension is to a large extent precipitated, by reason of its greater specific gravity, during the passage of the water through the vertical tubes and rear headers.

These boilers are made for working pressures up to 500 lbs. per square inch, and for burning any kind of fuel.

The Babcock and Wilcox Patent Steam Superheater consists of a number of solid-



BABCOCK & WILCOX PATENT WATER-TUBE BOILER, FITTED WITH SUPERHEATER

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Babcock & Wilcox

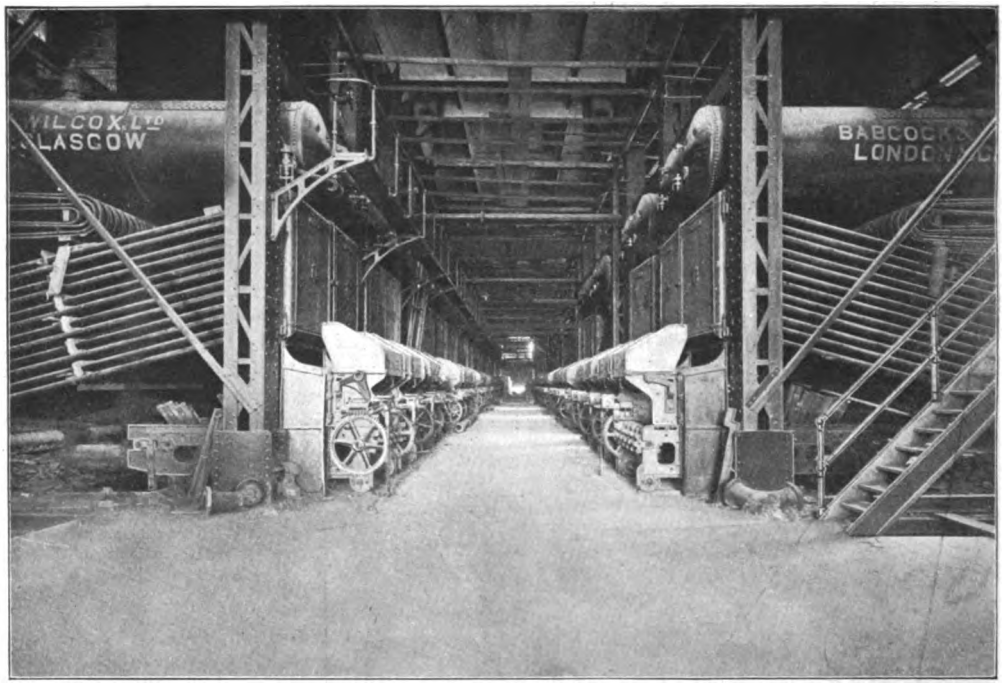
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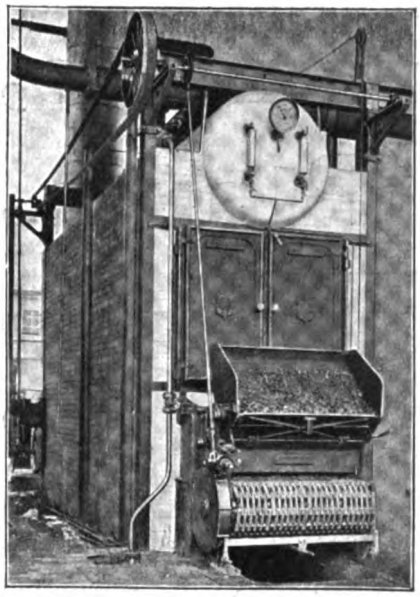
Sixty-Four Babcock & Wilcox Boilers, each of 5212 square feet heating surface, fitted with Superheaters and Chain Grate Stokers, in course of erection.

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MECHANICAL CHAIN GRATE STOKER ATTACHED TO BOILER.

drawn steel tubes, bent into a U form, and expanded at each end into wrought-steel boxes or manifolds. The steam from the boiler, entering the upper manifold box, divides amongst the U tubes, and during its passage through them becomes superheated, or raised to a higher temperature than previously, the pressure remaining unaltered. The use of superheated steam ensures a saving of some ten to fifteen per cent. in the steam consumption of even a modern highly economical engine; whilst, with older and more wasteful engines, the saving is considerably greater—thus the importance of the subject is self-evident.

The Chain Grate Stoker is designed for the efficient and smokeless combustion of semi-bituminous fuel. The grate consists of an endless chain of short cast-iron grate-bars, linked together, passing over drums at the front and rear, the front drum being revolved by a worm and worm wheel. The feed of the coal is slow, and the gases evolved from the fresh fuel pass underneath a highly heated fire-brick arch, and over the incandescent coal, and complete their combustion before coming into contact with the boiler heating surface.

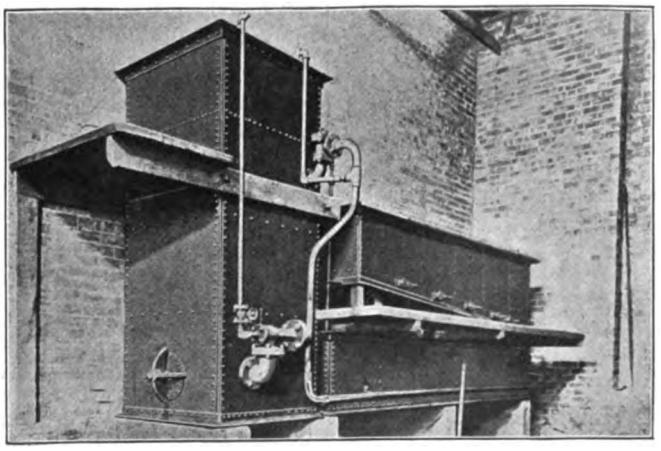
The fuel is gradually consumed as the grate travels on, and when the dumping bars are reached, there should be only ash and clinker, which, passing over the dumping bars, fall into a receiving pit provided with a hinged bottom, which is opened as and when required to allow of the clinker being removed.

The depth of the fuel and the speed of the grate can be adjusted in a minute to suit the conditions of draught available, the class of coal to be burned, and the evaporation required.

The stoker can be driven from a shaft, either overhead or underground. It can also be worked by hand, by a crank placed on the end of the worm shaft. Should the working of the stoker from any cause be temporarily affected, hand firing may be resorted to at a moment's notice.

The Guttmann Softener, manufactured by Babcock and Wilcox, Limited, has been designed for the purpose of removing, by chemical means, the scale-forming matter from water, prior to its use, thereby preventing damage to boilers, &c., from the accumulation of incrustation. This effects, at the same time, a large saving in fuel by keeping all parts of the boiler-heating surface in a clean and efficient condition.

It requires no attention or labour other than the filling of the chemical tank every morning, and periodical cleaning. It works automatically, a float regulating the admission of the hard water and of the soda solution in proportion to the quantity of soft water drawn off.



BABCOCK & WILCOX WATER SOFTENER (Oscar Guttmann's Patent).

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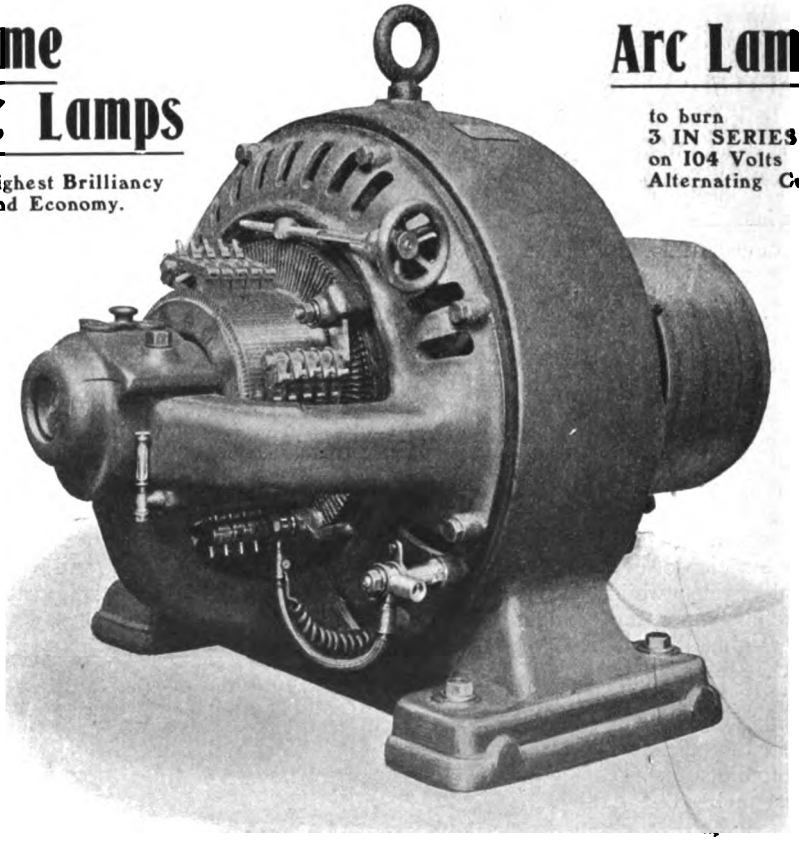
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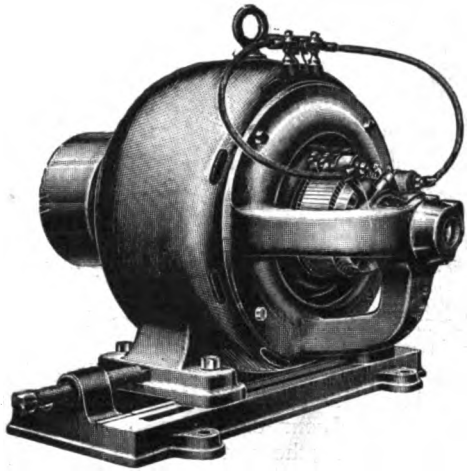
75, CITY ROAD, E.C.

Telephone: 4392 CENTRAL. *Telegrams:* "HANSA, LONDON."

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DURTNALL & PRIES' EXHIBIT.

A VERY interesting and extensive exhibit was that of Messrs. Durtnall and Pries, of 75, City Road, E.C. Several types of small dynamos and motors were on view, and we were informed that these were made in sizes up to 72 kw. and 90 h.p. Both



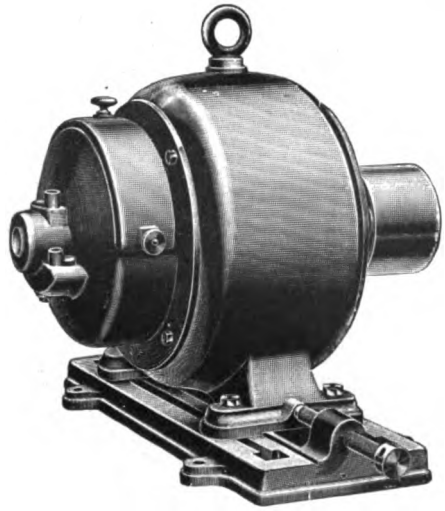
TYPE D.P. MOTOR—OPEN.

patterns are well built and of neat design, being made in open, ventilated enclosed, enclosed, and totally enclosed forms. Cylindrical poles with laminated tips are cast into the field yoke, and former wound coils, readily interchangeable, are used. The armature is of the usual slotted drum type, with former wound coils and substantial commutator. Special brush holders are fitted with carbon block brushes secured firmly with a clamping screw. All machines are rated to give full load for six hours continuously, without a temperature use exceeding 85° F., and 25 per cent. overload can be safely applied for half-an-hour. The motors are standardized for voltages of 220, 440, and 500, and the dynamos will give pressures, from standard sizes, of 110 to 500 volts.

On the same stand was on view a most valuable collection of portable electric drills for almost every conceivable class of work where holes of small and large sizes require drilling. The handy little machines should find a place in every workshop adjoining electric power supply mains, as innumerable uses can be found for them. They are possible of application in positions practically inaccessible to ordinary drills, and they further get through the work with an economy and despatch which is nothing short of surprising.

By means of a flexible wire and a suitable adapter, they can be instantly connected to any existing electric fitting. The machines are provided with series wound motors, which are more capable of withstanding heavy overloads than are shunt wound motors. Great attention is paid to efficient insulation, and every machine is carefully tested before leaving the works. The covers enclosing the commutator and brush gear are easlly removed for inspection, and the lubricating devices are ample to ensure smooth running. The machines are made in three types to meet the various requirements.

Type A for light work, B for moderate, and C for heavy work. Type A is recommended for drilling holes up to $\frac{1}{4}$in. in wrought iron, type B for heavier work and holes up to $\frac{3}{4}$in., and for still heavier work type C is advised. Besides the drilling machines referred to Messrs. Durtnall and Pries also construct combined bench and



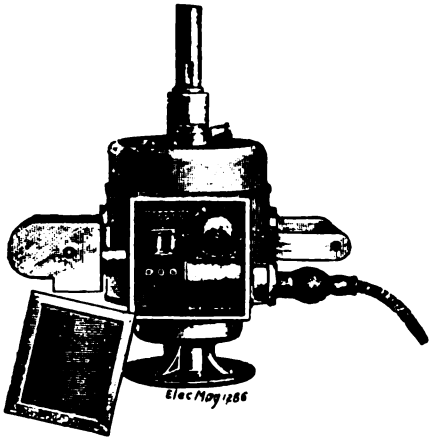
TYPE D.P. MOTOR—ENCLOSED.

hand drilling machines. These comprise bench drilling machines with attachment for hand drilling machine type B. The latter can be taken off instantly and used for work for which a bench drilling machine is not suitable. To reduce the risk of overloading

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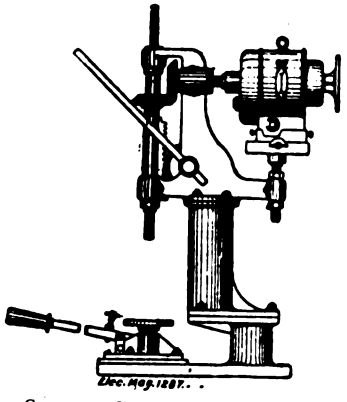
the machines to a minimum, a patent overload alarm is used which can be mounted in the base of type B and externally when either types A or C are used.

This apparatus causes an electric bell to ring directly the maximum current allowable



TYPE B. DRILL WITH OVERLOAD ALARM.

is exceeded, and stops again immediately the current has gone down to normal. It is thus impossible to overload the machine without the user's attention being drawn to the fact. The type A machine is constructed with and without reduction gear, and drills holes in wrought iron up to $\frac{1}{4}$in.



COMBINED BENCH AND HAND DRILL

Owing to its lightness and small size it is especially suitable for motor car and bicycle builders and light engineering work. The speeds range from 3,000 down to 250 revolutions, and the control is by press button provided with a bayonet lock in case it is desired to keep the drill running without attention to the button.

Types B and C are constructed with reduction gear only, and the speeds range from 600 down to 60 revolutions. The former is completely enclosed in an aluminium alloy casing. The breast plate is taken off by loosening a set screw, after which the cover can be easily removed, leaving the brushes and commutator exposed.

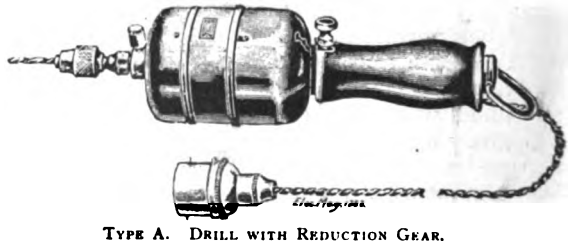
The control is in the right handle, and either two or four speeds are provided. If



TYPE A. DRILL WITH GEAR AND OVERLOAD ALARM.

the machine is to be used for thread cutting it is made to reverse, for which purpose a switch is fitted to the left handle. The speed regulation is obtained by means of a series-parallel connection of the field winding, and by altering the gear ratio.

The cases are made of aluminium alloy, giving both mechanical strength and lightness. The spindle of type A is fitted with a suitable cone for attaching ordinary almond drill chucks; in types B and C the spindle is fitted to take paper shank drills. Type C is chiefly adapted for drilling holes from



TYPE A. DRILL WITH REDUCTION GEAR.

$\frac{5}{8}$in. upwards, as well as for thread cutting and riming, and cannot be used for breast pressure. It can be used in conjunction with a pillar and swivel socket, and is constructed with a tension gear. It can also be used with a carriage, in which case one man is sufficient for drilling, riming, and counter sinking. By this arrangement a flexible shaft is dispensed with, thus avoiding costly repairs. On the same stand was also shown a number of arc lamps, switches, and motor starters.

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THOMAS ALVA EDISON AND THE PHONOGRAPH.

INTERVIEWS to journalists are very rarely granted by Mr. Edison, but his representatives in London have afforded us facilities which, owing to Mr. Edison's great organisation, fill up the gap.

We noticed at the Finsbury and Holborn Electrical Exhibition one of those conceptions of Mr. Edison, a phonograph worked electrically, and it may interest readers to hear something concerning his methods in connection with this instrument.

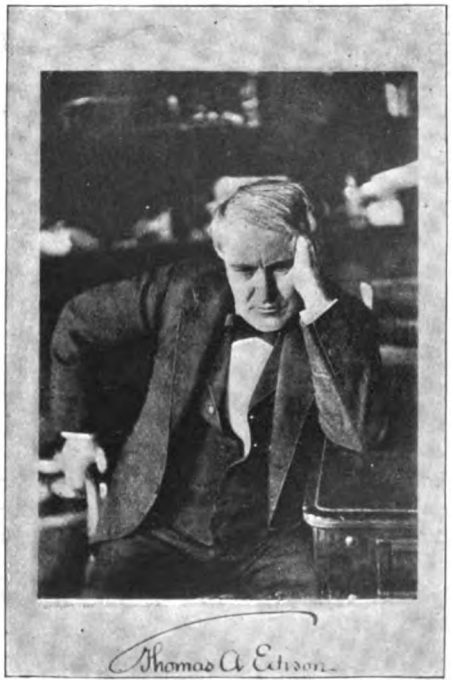
The materialisation of his ideas is perfected at the Edison Laboratory at Orange, New Jersey, and in connection therewith probably the room that has the greatest amount of interest for the public is that known as Room No. 13, or the Phonograph Experimental Department. Everything in connection with the "talking machine" is shewn here—sound development horns, phonographs of all sizes and their accompanying adjuncts, gold moulded records. The room is set aside particularly for experimental work, and in consonance with the usual American ideas, all those who labour within its precincts fill up their time with unerring devotion to the improvement of any particular detail which may bring about better results in recording or development of sound from records. Every conceivable measure is taken, which, with the assistance of the gentlemen planning perfection in this department, will tend to give to the purchaser of these wonderful machines an apparatus beyond the power of others to produce. Mr. Edison is a man of strenuous effort and grit, and whether it be in one department or another he leaves no stone unturned, and spares no effort or time to perfect that which he finally places before the world as "good." He works upon the principle that more can be learnt from things that go wrong than from things that go well, and always keeps in touch with those that work departmentally on his behalf, guiding and directing them to successful issues.

We offer our readers herewith a reproduced photograph of the machine which was working at the Finsbury and Holborn Electrical Exhibition, and a few particulars of it, as advertised by the National Phonograph Co., Ltd., of 25, Clerkenwell Road, E.C. It is called the Edison Victor Phonograph, and plays the standard size record. The price is £13 13s.; catalogue No. A 3,000; code, Victor. Size:—Height, 11⅛ inches; base, 20¾ inches by 10 inches. Weight:—net, 48lbs, gross, 100lbs, packed in one case. Equipment:—Model C Reproducer, New Edison Recorder, 14-inch horn, sapphire shaving knife, camel's hair chip brush. Option:—Speaking tube or hearing tube instead of 14-inch horn. (This machine can also be supplied with specially finished Mahogany Cabinet, at an extra charge of 17s.)

Mechanism sets in an oak body box, and is finished in black and gilt enamel. The mandrel is nickel-plated and polished, equipped with electric motor (wound for battery). Motor requires a steady current of 2½ volts and 2 amperes. Its uniform action and continuous power supply recommend the VICTOR Phonograph for all occasions where these requisites are desired.

(The battery is not a part of the Phonograph but is an independent apparatus.)

As the story of how Mr. Edison came to invent the phonograph has been told with many variations, it may be interesting to



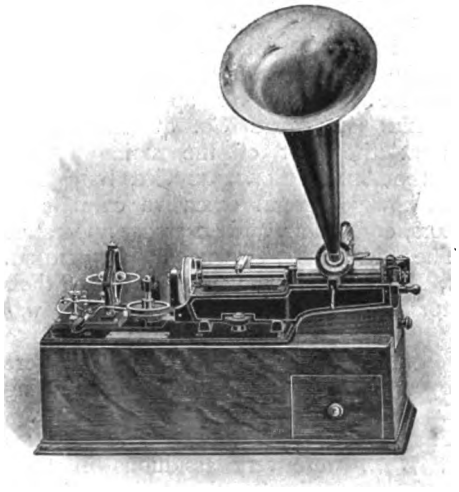
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relate how this idea actually came to be put into execution. Briefly, in his early work with automatic telegraphs operated at high speed, Mr. Edison had occasion to experiment with embossed strips impressed with dashes and dots thereon, which were moved rapidly beneath a stylus to vibrate it. It was observed that this stylus in vibrating produced audible sounds. Mr. Edison's active brain therefore immediately grasped the fact that if the undulations on the strip could be given the proper form and arrangement, a diaphragm could be vibrated so as to produce any desired sounds. The next step was to form proper undulations on the strip and then the idea was suggested to Mr. Edison's mind



THE EDISON VICTOR ELECTRICAL PHONOGRAPH.

that these undulations could be produced by sounds themselves which could then be reproduced. When this conception was reached the phonograph was commercially possible.

Readers may be interested to learn that the first patent on the phonograph was filed in the United States on December 24th, 1877, and was granted February 19th, 1878, No. 200,521.

Mr. Edison has never spoken into a phonograph for the purpose of making a record. When the idea was suggested that if he did so it would have an enormous sale he said he might some day tell the phonograph how he invented the machine, but it was not yet likely.

There are reasons why the Edison Phonograph is more sought after than other makes.

First, because you will find after making the most careful investigations that it possesses more points in its favour than any similar device on the market, and its capabilities for amusement are not equalled by any musical instrument in existence.

The reproducer is a most important part of the Edison Phonograph; the model now in use was invented by Mr. Edison about four years ago. So nicely does it do its work that there is an entire absence of the harsh and disagreeable scratchy sounds caused by imperfect reproducers. The smooth, round, sapphire point of the Edison reproducer does *not* require frequent changing, nor does it wear itself or the record with which it comes in contact, consequently, Edison Gold-Moulded Records last for years.

With an Edison Phonograph you may make records of your own or your friends' voices, an inexhaustible means of home amusement and something not possible with other types of talking machines.

The Genuine Edison Phonograph is guaranteed by its Inventor, whose trade mark signature appears below, and the more its merits are investigated by the careful buyer, the better pleased will he be with it.

The Offices of the National Phonograph Co., Ltd. in London are situate at 25, Clerkenwell Road, E.C., being the European Headquarters for Edison Laboratory Products.

TRADE

Thomas A Edison

MARK



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OTHER ELECTRICAL EXHIBITS.

THERE was no lack of representative patronage of the Exhibition by important electrical firms. Everything electrical was on view, from a pea lamp to a 50-h.p. motor. Space does not permit us to refer in detail to all the exhibits, but we give a few notes of the most interesting stands and apparatus.

The REASON MANUFACTURING CO., LTD., of Brighton, were prominently placed near the entrance on the ground floor, and had on view a large number of the meters, fuses, boxes, street lighting fittings, and arc lamps, for which they have become famous. Among other special devices were noticed electric time switches for two-rate meters and for automatically switching on street lamps.

E. F. MOY & CO., LTD., were well represented on a large stand, occupying nearly the whole of one side of the ground floor back. Here were exhibited large quantities of fuse boxes and iron-clad switches, Mordey patent fuse, and distributing boards. A feature of the exhibit was a discriminating cut-out for protecting continuous current dynamos when running in parallel.

CALLENDER'S CABLE AND CONSTRUCTION CO., LTD., occupied a handsome stand, where every size and type of their cables were on view.

The INDIA-RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS CO., LTD., exhibited specimens of wires and cables, recording instruments, and rubber gloves and mats. Several motors of the Company's make were also open to inspection.

The ELECTRICAL CO., LTD. were conspicuous by their two brilliantly-lighted stands, on which many types of arc lamps, fans, motors, and other apparatus were displayed. The visitors were quite dazzled by the bright glow from a number of "Lunar" flame arc lamps.

The stand of MESSRS. GEIPEL & LANGE faced the entrance to the ground floor back, and could not very well be missed. The Vulcan speed indicator attracted considerable attention, as did also several specimens of heating apparatus. Much interest was also placed in a "turn-down" electric lamp.

The DOWSING RADIANT HEAT CO., LTD., delighted many visitors with their solarium or electric sun bath. It is claimed that this apparatus has many advantages over the vapour bath now in use.

At the stand of MESSRS. JOHNSON & PHILLIPS was an attractive show of switchboard and portable ammeters; also a number of the hot wire instruments for which the firm are renowned. The stand was ablaze with light from four "Ark" lamps. An item of interest to central station men was Griffiths and Biliotti's thermal time element cut-out.

At the stand of the SIMPLEX STEEL CONDUIT CO., LTD., a large framework composed of the firm's tubes, conduits, and fittings had been built up, and at once attracted the attention of the visitors.

In the basement was a splendid showing of motors and power apparatus. The WESTERN ELECTRIC CO. attracted attention at the foot of the stairs, as did also the ADNIL ELECTRIC CO., both concerns having several extensive exhibits of motors, controllers, and accessory apparatus.

The MORRIS HAWKINS ELECTRICAL CO., LTD., exhibited various types of their motors, while considerable attention was drawn to the stand by several machines to which motors were coupled, and which were in operation. Among these were a printing press, a dough mixer, and a boot polisher.

The BRUSH ELECTRICAL ENGINEERING CO., LTD., were very assiduous in their attention to callers, and readily explained the details of their apparatus on view. A number of other large motors were to be seen, together with controllers and starting switches; both alternate and direct current types were shown.

The motors, dynamos, and switch gear of the UNION ELECTRIC CO., LTD., made up an attractive exhibit in a prominent corner; while directly adjoining was the stand of MONTE CALLOW & CO., on which the "Ensea" starter, which possesses many novel features, was to be seen.

The ELECTROMOTOR & DYNAMO CO., MESSRS. ELLIOTT BROS., and J. RICHMOND & CO. also had exhibits.

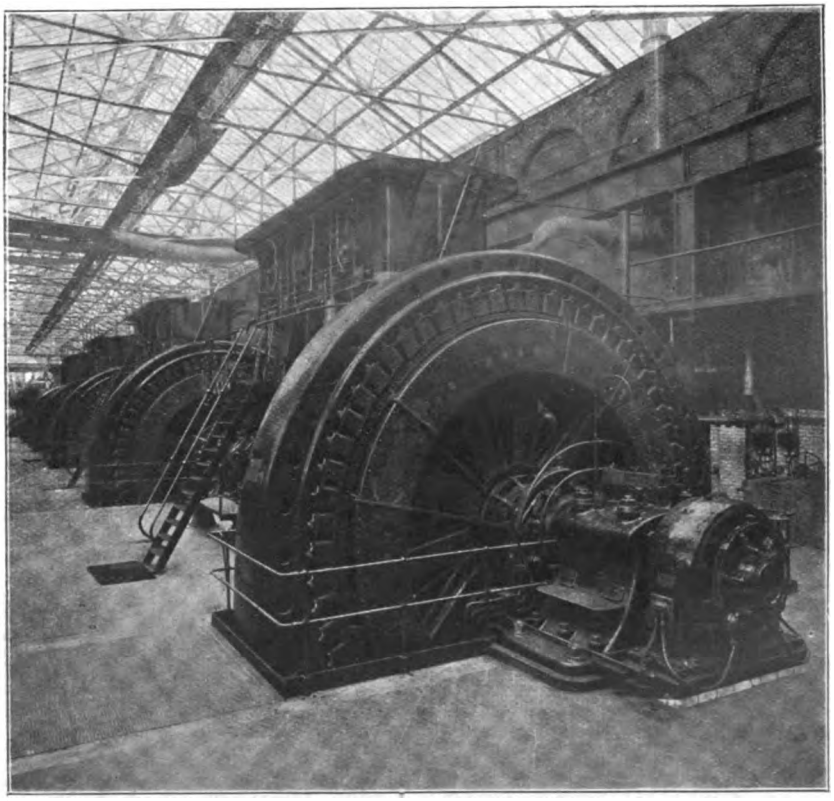
The BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO., LTD., had a number of meters, switches, and motors exposed on view under the glare of a number of Cooper-Hewitt lamps fixed about its stand. The latter attracted considerable attention.

Do not forget next month we publish another Exhibition Supplement.

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The Paddington Electricity Exhibition.

THIS Exhibition, organised by one of London's most enterprising power companies, the Metropolitan Electric Supply Co., Ltd., was opened on March 25th, by the Mayor of Paddington. The Exhibition, which was an undoubted success from every point of view, closed on April 8th. From the electrical manufacturers' standpoint, the Exhibition was well patronised, and, according to the official catalogue, there were forty stands allotted to representative electrical firms. We give, in the following supplement, particulars and illustrations of the more important exhibits, from which it will be noticed that there was no lack of zeal and enterprise on the part of the exhibitors. The Metropolitan Electric Supply Co., Ltd., are to be congratulated on the business acumen they have displayed in bringing the project to a successful issue, for we understand that no fewer than 37,000 persons passed the turnstiles and considerable business was done during the time the apparatus was on view. The arrangements were in the hands of Mr. Page, who was presented at the close of the Exhibition with a handsome silver cigar-box.



INTERIOR OF METROPOLITAN ELECTRIC SUPPLY CO.'S ENGINE ROOM AT WILLESDEN. FIVE GENERATORS, AGGREGATING 22,500 H.P., ARE SHOWN ABOVE. THE OTHER PLANT IS DEPICTED ON PAGE 3. A 5,000 H.P. SET IS BEING ERECTED.

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THE METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED,

Supply Electrical Energy throughout the districts of Paddington, Holborn, the Strand, St. Giles', and St. Martin's-in-the-Fields; and (as Agents for the Borough Council) in Marylebone. Also in bulk to the Acton District Council.

✂ ✂ ✂

NEARLY ONE MILLION 8-C.P. LAMPS

ARE AT PRESENT SUPPLIED.

✂ ✂ ✂

Specially Advantageous Rates of Charge quoted to Power and Long-hour Users.

✂ ✂ ✂

FREE WIRING for SMALL HOUSES and SHOPS.

✂ ✂ ✂

Wiring on the Hire-Purchase System.

✂ ✂ ✂

Full Particulars can be obtained at the

Company's Office, 16, Stratford Place, W.

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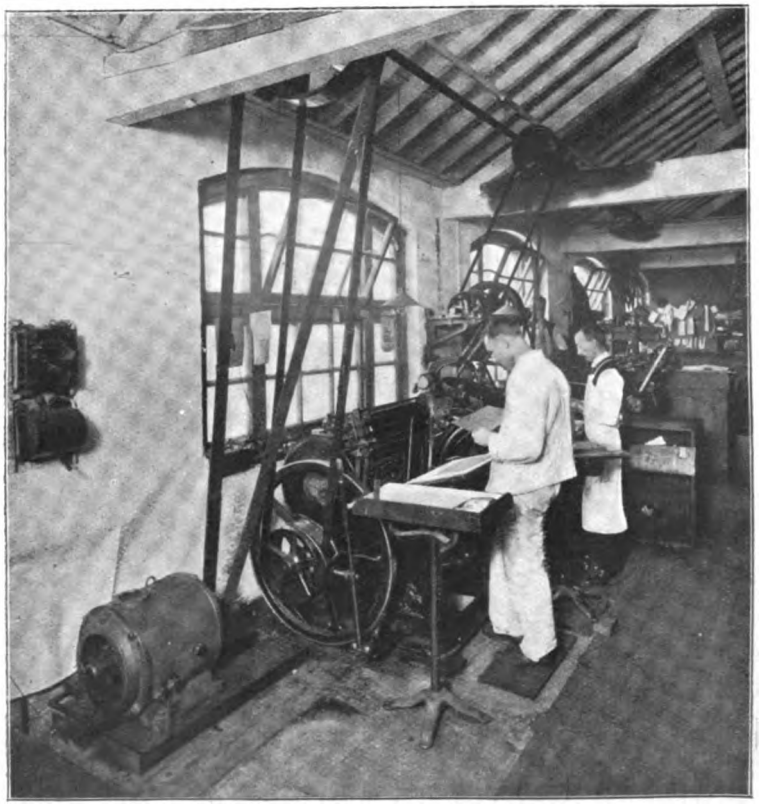
THE METROPOLITAN ELECTRIC SUPPLY CO., LTD.

THE Metropolitan Electric Supply Company, Limited, is the largest undertaking of a similar nature in the United Kingdom. It supplies electrical energy throughout the Boroughs of Holborn and Paddington, the eastern half of the City of Westminster, and in the Borough of Marylebone as agents for the Borough Council. It also supplies in bulk to the Acton District Council, and in the Company's Various Powers Bill now before Parliament it is seeking powers to supply local authorities and companies in bulk throughout West London and a large portion of Middlesex.

The total number of eight-candle power lamps now connected amounts to nearly one million.

To meet this large demand, the Company possess large generating works at Willesden, where plant of upwards of 20,000 horse power is at present in operation. The existing works cover about five acres, and the Company own an additional fifteen acres for the purposes of meeting future demands. From these works the electrical energy is conveyed at 10,000 volts by means of two independent systems of trunk mains to transforming sub-stations situated in various positions in the areas of supply; and at many of these sub-stations large storage batteries are installed as an additional security against any temporary interruptions of supply.

Especial attention is being paid by the Company to the growing demand for electric motors. Motors can be purchased, hired, or obtained on the hire-purchase system, and



NOTE ON THE LEFT THE EXTREME COMPACTNESS AND SIMPLICITY OF THE ELECTRICAL EQUIPMENT.

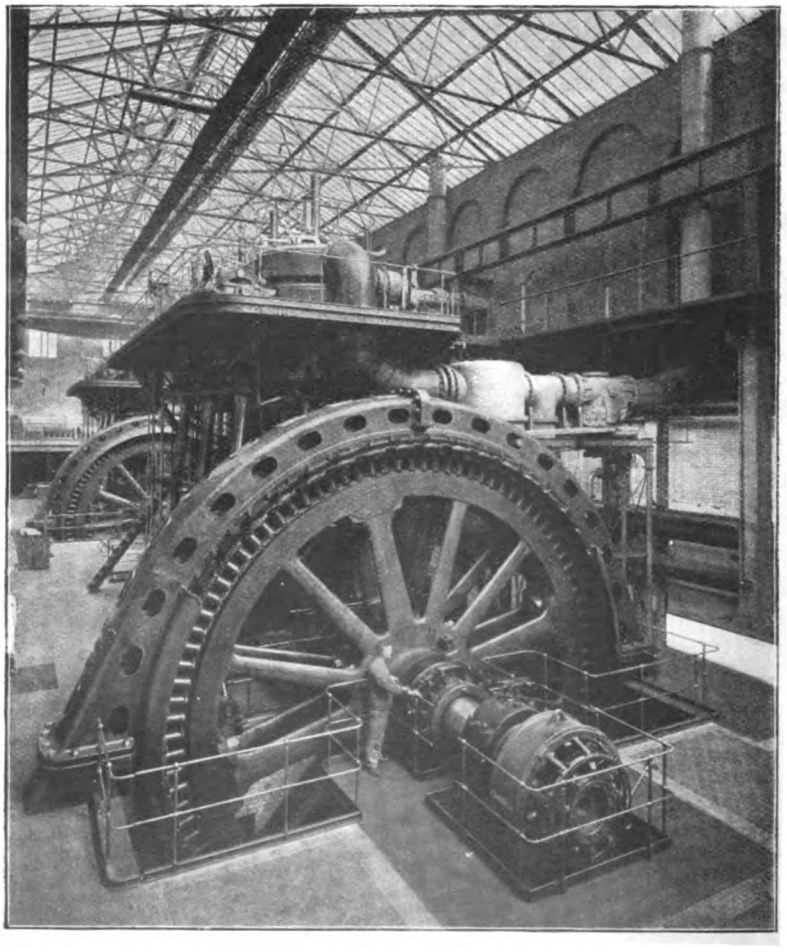
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very low rates are quoted for current. The Company's motor load has doubled itself each year for many years past, and there is no doubt that before long it will at least equal the lighting load. At the recent Paddington Exhibition, a very interesting and instructive display of motors was made which has resulted in a great stimulus being given to this branch of the Company's business.

The motors exhibited were all coupled to various machines which were shown in motion. A 5 h.p. motor was operating a dough kneader; a 3 h.p. was connected to a circular saw, and a 2 h.p. machine was operating a chaff cutter. Alternate current motors ranging from ¼ h.p. to 10 h.p. were also on view. Two motor-car battery charging sets attracted considerable attention. They comprised 3½ k.w. motor generators and charging boards, with all switches and instruments.

With a view of encouraging the general use of electricity and of bringing it within the reach of all, the Company have introduced systems of free wiring and hire-purchase wiring, full particulars of which can be had on application.

The Company's Office is at 16, Stratford Place, Oxford Street, W.



TWO OF THE STEAM GENERATORS OF THE COMPANY'S WILLESDEN WORKS. THEY ARE OF 5000 H.P. CAPACITY EACH, AND THE LARGEST OF THEIR KIND IN EUROPE. THEY CAN EACH SUPPLY ELECTRICAL ENERGY TO 100,000 8 C.P. LAMPS

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BABCOCK & WILCOX CONVEYORS.

MECHANICAL methods of handling large quantities of materials, such as coal, coke, ashes, ores, macadam, &c., offer to the enterprising owner or superintendent of works splendid opportunities of saving money in these processes. In steam generation alone, an immense saving can be effected by discarding obsolete methods of handling, and adopting the most modern mechanical applications of conveying plant.

Many large power stations have been established in situations where mechanical and automatic handling is not of the easiest or cheapest application; but even in the most adverse cases, a large margin of saving may be found, and where power installations have been erected with a view to utilising mechanical handling, the saving is always most satisfactory.

The Babcock & Wilcox conveyor, on account of its flexibility of application, can be adapted to almost every case, however complex or awkward, and still enables the user to save a large yearly sum, after allowing for capital expenditure and working expenses.

This conveyor has many outstanding features of excellence which places it in the front of all other systems or imitations. It is in reality a series or train of tipping cars linked together, and the whole system so perfectly balanced that to operate it the minimum power is necessary; the power required to lift any quantity of material through any height being the mechanical equivalent of the work done.

The driving device is also a very important feature. The driver may be actuated by any motive power obtainable, and consists of a spur-geared engine operating two sets of pawls, which successively thrust the chain in the direction of its travel, engaging with both sides simultaneously. By this device any wear in the chain links is compensated, and a chain works as freely and easily after years of constant use as when newly started and the cost of up-keep is practically nil.

Another special feature of this conveyor is the application of free or revolving curves where the direction of the conveyor is changed, either from the horizontal to the vertical in the same plane, or at any angle to the first plane of motion. In descending from an upper run to any depth the maximum stress is at the point of turning to descend, and here the wheels carrying the chain and buckets cease to rotate as soon as they touch the revolving free-wheels, and when movement ceases friction also ceases, and, consequently, wear on the chain, wheels, and axles.

The power required to drive a Babcock & Wilcox conveyor can be easily estimated with fair exactitude, and should be taken as made up of two parts: First, the power to drive the conveyor empty; and second, the power required to raise a certain weight of coal per minute through a given height. Experiment has decided the first; and the second, as already stated, is the mechanical equivalent of the work done. The power to drive this Conveyor is phenomenally small when compared with that of other systems.

The conveyor is practically automatic in its cycle of action, no handling being necessary from the point at which the material is delivered into the receiving hopper, until it is discharged, further than moving the levers of the dumpers to fill up the sections requiring to be operated on.

An approximate idea of the cost of handling by the Babcock & Wilcox conveyor may be formed when we state that in conveying and lifting 40 tons per hour to a height of 40 feet, 10 hours per day, by a conveyor costing £1,000, allowing for interest on capital expenditure, attendance, oil, motive power, depreciation, and repairs, the cost works out at less than ½d. per ton.

GENERAL CONSTRUCTION.

The buckets are of mild steel stamped out of one sheet by a special hydraulic process, and have each a pair of combined cams and trunnion bearings of malleable cast iron strongly riveted on, and formed so that a bucket can be detached in a few seconds without disturbing any other parts of the Conveyor. The chain consists of two double link chains, each link made of flat steel, and steel stud-rivets forming distance pieces for the pairs of links. The steel of which these are made has a tensile strength of about 62,000lb. per square inch section.

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BABCOCK & WILCOX LTD.

. PATENT .

Silent Gravity Bucket Conveyor.

ADVANTAGES:

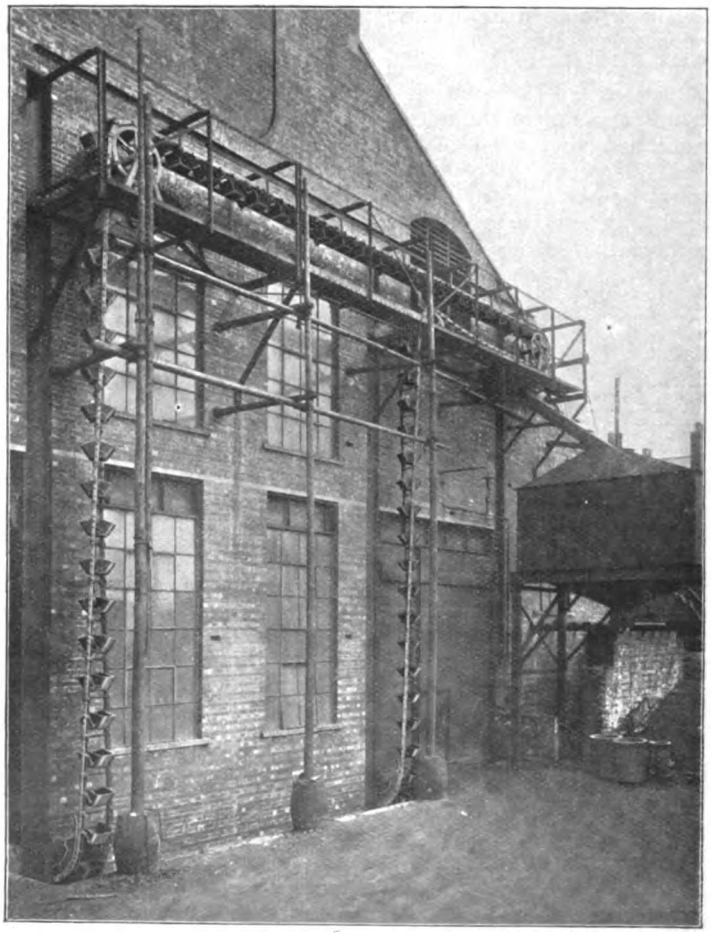
Saving in Cost of Handling.

Small Driving Power.

Automatic Action.

Silent Working.

Durability.



ADVANTAGES:

Flexibility of Application.

Interchangeability of Parts.

Economy of Maintenance.

Perfect Balance of Parts.

OLDHAM ELECTRICITY WORKS.—Ash Conveyor, having a capacity of 20 Tons per Hour.
The above Illustration shows the Flexibility of the Conveyor in the Vertical Plane.

A UNIVERSAL CONVEYOR FOR . .

Electricity-Generating Stations, Gasworks, Coal Yards, Chalk and Cement Works, Shipping Docks, Locomotive Coaling, and Manufactories.

***Head Offices:*—Oriel House, Farringdon Street, London, E.C.**
***Works:*—RENFREW, SCOTLAND.**

In dealing with Advertisers please mention The ELECTRICAL MAGAZINE.

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NORTH METROPOLITAN ELECTRIC SUPPLY CO., BRIMSDOWN. BABCOCK & WILCOX CONVEYOR. CAPACITY 40 TONS PER HOUR.

The oil is supplied through special spring top brass lubricators inserted in the chain-wheel bosses, which exclude dirt.

The process of dumping or tipping is effected by a pair of cams carried by a cross shaft coming into contact with another pair of cams riveted on the ends of the buckets and causing the buckets to tip up at an angle sufficient to completely empty the contents, and these dumpers can be applied at any points of the horizontal runs.

The filling mechanism consists of a series of seven hoods with openings over the buckets, for preventing the spilling of coal. All parts of the Conveyor are constructed to jigs and templets, and are consequently interchangeable. The Conveyor is made in sizes capable of handling respectively 20, 40 and 80 tons of coal per hour.

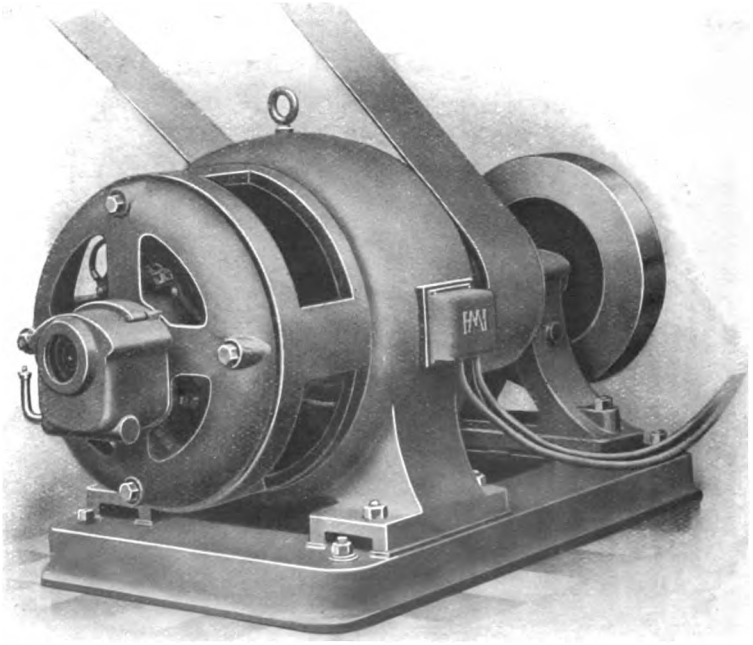
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MORRIS-HAWKINS MOTORS & DYNAMOS

Stocked for immediate delivery at our Works,

DAGENHAM, ESSEX.

Standardised 1 H.P. to 100 H.P.



MORRIS-HAWKINS 50-H.P. MOTOR.

With Third Bearing and Fly-Wheel.

THE MORRIS-HAWKINS ELECTRICAL Co., Ltd.

Head Office: 17, CHARING CROSS ROAD, LONDON, W.C.

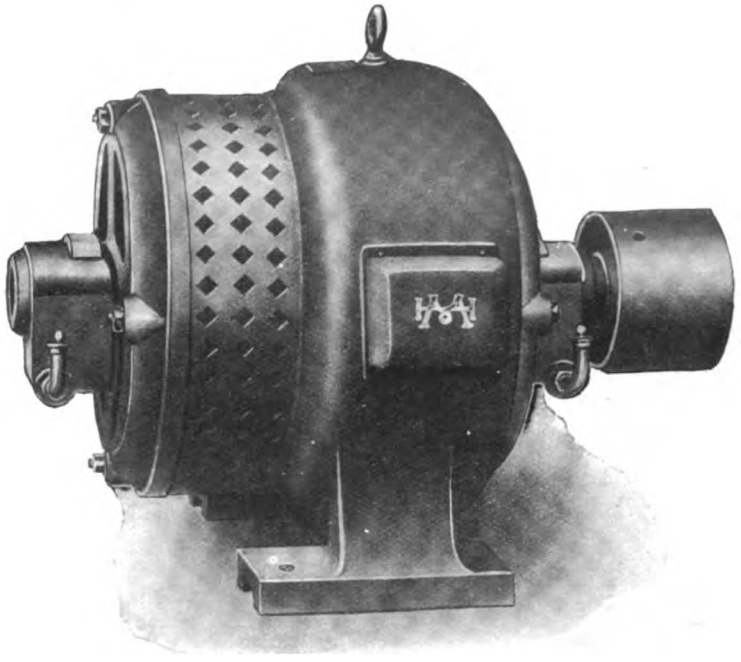
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MORRIS-HAWKINS ELECTRICAL EXHIBIT.

THE Morris-Hawkins Electrical Co., Ltd., had a large stand at which they exhibited the various types of motors in which they specialise, and which they have standardized up to 100 h.p. The motors on view ranged in size from 1 to 25 b.h.p., and a number were coupled to machines shown in operation. A motor-generator set comprising a two-phase motor coupled to a continuous-current generator both mounted on one bed-plate was placed in a prominent position on the stand.

The motors of the company are all manufactured at their works, Dagenham, Kent, where special modern machinery has been installed and up-to-date methods employed in the production of a reliable and efficient motor. The design of the motor ensures a compact, light machine with four poles, slotted armature, and carbon brushes, a combination giving high efficiency while at the same time allowing of a rapidity of manufacture which means quick delivery to the customer. A feature of the manufacture is the employment of a special grinder for finishing the motor shafts. This tool, in conjunction with highly accurate lathes used to turn up the shaft in the first instance, enables the shaft to be ground perfectly true, and, as a consequence, friction in the bearings of the finished motor is reduced to a minimum. The commutator, which is very important, receives particular attention in manufacture. The bars, of uniform section, are made of the best hard drawn copper and insulated with shell mica. After assembling, they are submitted to hydraulic pressure of from 80 to 100 tons. A baking process follows, which gives the segments a true concentric position and prevents further shrinkage. A strong, neat form of carbon brush holder is in use, and is maintained uniform through all sizes of motors. All machined parts of the motors are made strictly to limit gauge and templet, so that absolute interchangeability can at all times be guaranteed.

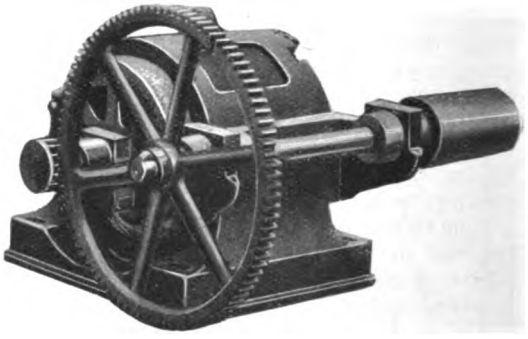


Morris-Hawkins Standard Enclosed Ventilated Motor.

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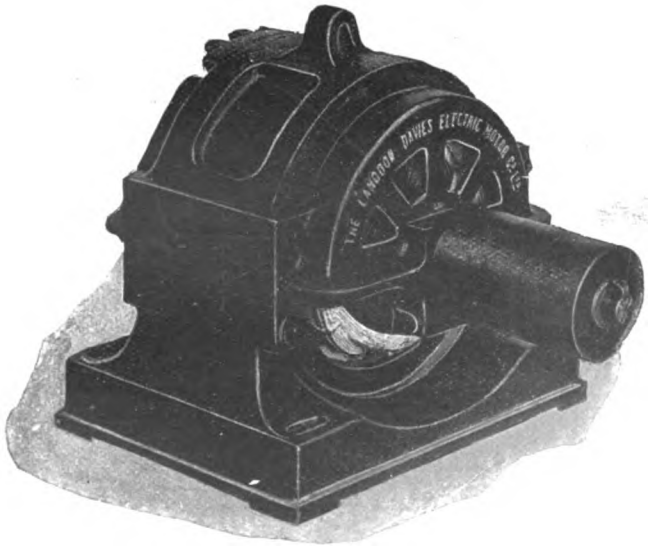
THE EXHIBIT OF THE LANGDON-DAVIES ELECTRIC MOTOR CO., LTD.

An extensive exhibit was that of the Langdon-Davies Electric Motor Co., Ltd., of Deverell Street, S.E. This company has specialised the manufacture of single-phase motors for a number of years, and many thousands of their machines are in use on alternate-current circuits. These motors exhibited were coupled to various kinds of industrial machines, all of which were shown in motion. Among these we noticed a chaff cutter driven by a 3 h.p. motor, a 2 h.p. motor operating a Kinetic Swanton organ-blower, and a sausage chopping machine, driven by a 2 h.p. motor. The chief features of the motors are: They are self-starting; starting current does not exceed full-load current; there are no brushes, commutators; or connecting rings; there is no sparking, no skilled attention is required; and the cost is very low. As compared with a gas engine, the Langdon-Davies motor has special compensating advantages. It starts by itself, is free from noise and smell, and is both small and cleanly. It gives practically no heat, is very steady in running, and, as there are only two bearings, the cost for upkeep is very low. It is almost needless for us to point out that the best modern gas engines of small output do not possess any of these important features. The gas engine is so frequently put forward as a serious competitor to the electro-motor, that these



SINGLE-PHASE MOTOR WITH REDUCTION GEAR.

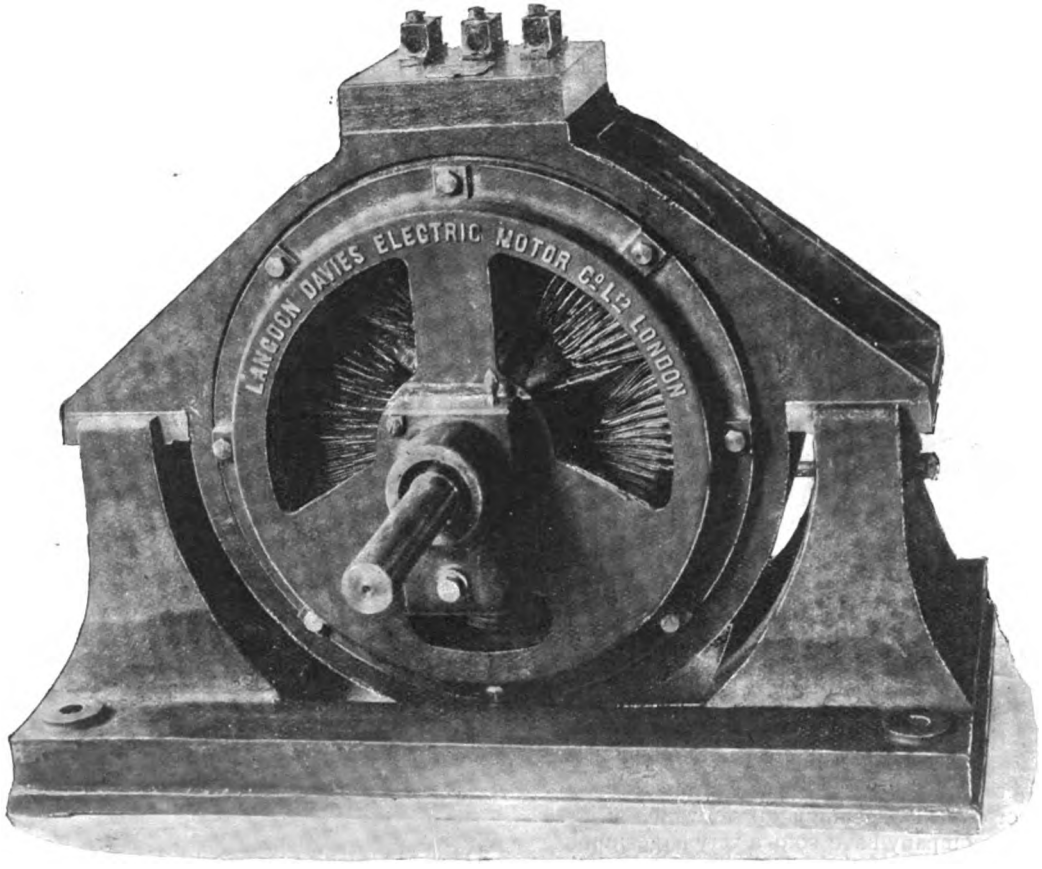
facts regarding the latter are frequently overlooked. On circuits where the charge is 1d. per unit, the cost of power for a 3 h.p. Langdon-Davies motor does not exceed 1d. per horse power per hour. By this is meant the power exerted by the motor at the particular time, and not the rating of the motor itself. The electrical energy consumed is approximately in direct proportion to the load on a motor from one-third or less to full load.



4 H.P. LANGDON-DAVIES MOTOR.

The motors are manufactured at the large works of the company in Deverell Street, Southwark, where the latest types of machine tools are installed. The use of these in conjunction with organised workshop methods allow of the production of high efficient machines with an economy ensuring a moderate price and a despatch which guarantees quick delivery. The motors can be supplied for direct connection to such machines as pumps, fans, hoists, tools, &c., and they are generally belted to bottling machines, printing machines, confectioners' and bakers' appliances, organ blowing, wood-working machinery, &c. A special spur reduction gear is supplied

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25 H. P. SINGLE-PHASE LANGDON-DAVIES MOTOR.

when required; in fact, the company are prepared to meet any reasonable demands and adapt their motors to the special requirements of power-users when asked to do so.

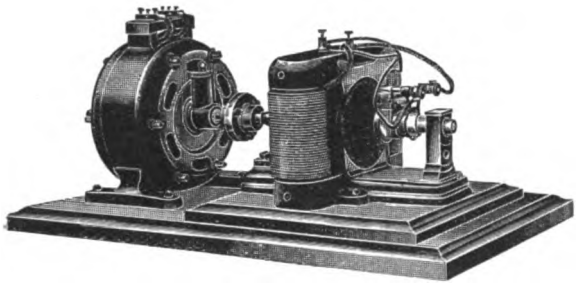
A number of continuous current motors were also put forward for inspection. A regular line of these is manufactured by the company in sizes from ¼ to 35 b.h.p.

These machines are of the iron-clad type, and all the moving parts (with the exception of the pulley), including the brush gear and connections and windings, are fully protected by the frame. The bearings, which are of the ring lubricating type, are bushed with hard phosphor bronze, and the shaft is made of the best mild steel. The brushes are of special high-grade carbon, and the pressure spring of each is adjustable. The commutator is of hard-drawn copper insulated by mica only, and the bars are of ample radial depth to allow for wear and turning up. The armature is built up of slotted annealed soft iron plates insulated from one another by special treatment and keyed on to the shaft. The coils are former wound, and carefully dried and insulated before being assembled. The field coils are specially wound on steel frames, and carefully insulated and dried previous to fixing in position.

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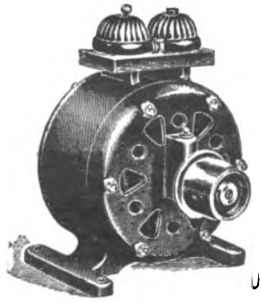
THE CRYPTO ELECTRICAL CO.'S EXHIBIT.

AN exhibit which attracted a very considerable amount of attention was that of the Crypto Electrical Co., of 3, Tyers Gateway, Bermondsey, S.E. The Metropolitan Electric Supply Co., being one of those companies which furnish an alternating current, this stand should have been of particular interest to all their consumers supplied with this form of power, as the Crypto Co. showed several of their small alternating-current motors at work.



ALTERNATING TO CONTINUOUS TRANSFORMER.

The above block is an illustration of an alternating to continuous-current transformer to enable those situated on alternating-current mains to obtain a continuous current for charging accumulators (for which purpose the company have sold a very large number in all parts of the country) and for plating and medical purposes.

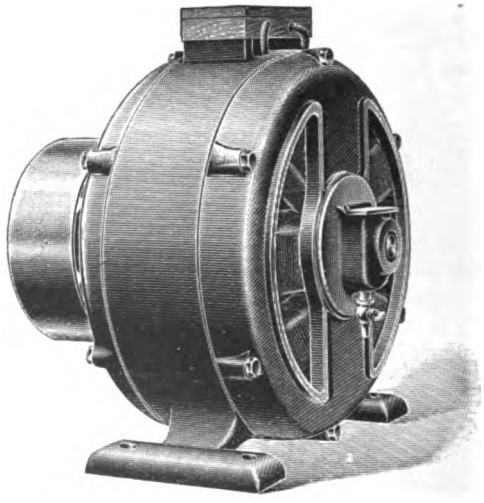


CRYPTO ¼ H.P. INDUCTION MOTOR.

This type of motor has been designed for light power purposes, and is largely used for driving hairdressers' brushes, for revolving cinematograph films, small lathes, dynamos, &c. If a motor is required to start up on full load, one cannot improve on the Crypto repulsion motor, which was also on view at the stand. The starting torque of the Crypto induction motor is remarkably high, and we understand that these motors will start up with considerable load.

The Crypto Co. have now been manufacturing small dynamos and motors for about ten years, and have therefore probably had more experience than any other makers in building charging dynamos, of which they had a good line on exhibition in sizes ranging from 25 to 3000 watts.

These machines are all very substantially built to stand the wear and tear to which they are subjected in garages.



CRYPTO 2 KW. ALTERNATOR.

The bearings are of the self-oiling ring lubricator type, and therefore require very little attention.

There were many other things of interest, among which we would mention the Crypto 8-pole alternator, which is made in two sizes, viz., 500 and 2000 watts. One of the latter size we noticed was built to the order of the Metropolitan Electric Supply Co., in connection with their change-over work. The products of this company are all manufactured at their well-equipped works situated in Bermondsey.

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THE EXHIBIT OF THE ELECTRICAL CORPORATION, LTD.

THE Electrical Corporation, Limited, of London and Birmingham, who have opened Show Rooms at 69 and 70, Aldersgate Street, where we recently inspected the latest electrical developments as applied to heating for domestic, commercial, medicinal, and other purposes, had an extensive exhibit. From the results obtained, electricity is undoubtedly beyond comparison with any other method of heating. The "Pluto" system now being exploited by the Electrical Corporation is patented and embraces several novel appliances, and is entirely unlike any other previously attempted method. It practically solves the difficulty of economically and commercially utilising electricity for heating and cooking, as all the heat obtainable from electrical energy is secured to its fullest extent, whilst concurrently the heating power is increased by mechanical means.

Briefly, the description of the system is that electric standards are arranged in an enclosed metal chamber, through which pass open-ended tubes or ducts. When the electric current is switched on, this chamber quickly becomes a reservoir of heat, which is conserved; the tubes are raised to a high temperature, with the result that air is drawn through, heated, and freely circulated. When the atmosphere is sufficiently warmed, the temperature can be practically maintained simply by one switch, as little of the generating heat is lost from the chambers. It will be at once seen that a given area is heated with a greatly-reduced consumption of current; moreover, another great consideration is, that it circulates pure air, which, entering the tubes at their base, becomes heated in progress. This has a sterilising effect; rapidly deals with the volume of air instead of burning up, drying, and deteriorating small portions. The temperature of a room is raised both quickly and economically to the desired degree, and afterwards maintained.

Another important feature of the system is that the heaters can be provided with a specially-designed circulating fan for use in lofty rooms, large areas, &c., for distributing the heated air. By this arrangement, the drawbacks attendant on other methods are obviated. All modes of heating hitherto in use started from one standpoint. A heated apparatus was placed in a room and it was necessary to wait until, by difference of density between warm and cold air, all the upper part of a room was filled with warm air before the lower part became heated. That is to say, the upper part of a room had to be overheated in order to obtain a slight elevation of temperature in the lower and inhabited portion. Such process is illogical, and anti-hygienic. The "Pluto" system gives immediate and absolute use of all the heat produced. It also obviates smoke, dust, disagreeable emanations and, principally, condensation produced by combustion, which, forming on cold surfaces, spoils decorations, tapestry, hangings, varnish, and gilding, whilst it deadens the colour of pictures, and causes rapid oxidisation of metal work.

Dr. Benjamin Ward Richardson, the celebrated London physician, found "after long experiments and practice that 64 degrees Fahrenheit is the best temperature in which to conduct mental labour. If the temperature falls below this the mind becomes drowsy and inactive, and if it rises much above, there is a relaxed state of the body and mind which soon leads to fatigue and exhaustion." It is most important that the temperature be the same in all parts of the room and that it be steadily maintained. The "Pluto" system does all this.

Another marked feature of the "Pluto" heaters is that the greatest care has been exercised in obtaining artistic and correct designs, whilst the make and finish is of the highest grade.

The "Pluto" system is designed to meet all conditions of the various voltages of the supply companies, current consumption, heating capacity, &c. For average conditions, it will be found that with the "Pluto" system approximately 1000 watts will be effective for every 1500 cubic feet. To obtain the best results, however, regard must be had to both construction of the building and the location of the room—to the character of the walls, the number of windows, and the actual conditions of ventilation. Equally important is it to decide upon the time in which it is desired to secure a given temperature. It is a high tribute to the merits of the "Pluto"

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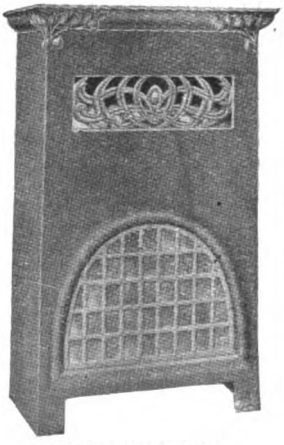
THE ELECTRICAL CORPORATION,
LIMITED.

LONDON: 69 & 70, ALDERSGATE STREET, E.C.

&

BIRMINGHAM: GLOBE WORKS, BROMSGROVE STREET.

PLUTO
SYSTEM OF
ELECTRIC HEATERS.



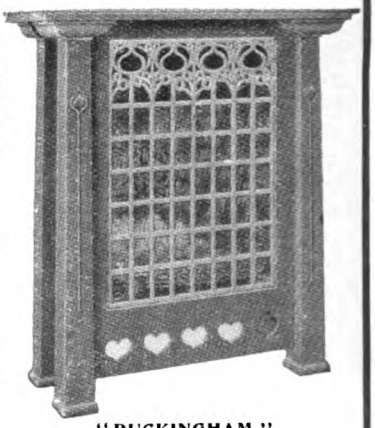
"BALMORAL."

(Patented and Registered.) Gold Medal and Diploma awarded Bath Exhibition.

Electricity is undoubtedly beyond comparison with any other method of heating.
From a hygienic standpoint this method of heating is perfect.
No combustion—therefore no fumes.
The atmosphere is not contaminated.
Great cleanliness and convenience.
Heat is produced by a simple movement of a switch.
Decorations, &c., are not deteriorated.
Absolutely free from danger.
Simplicity of handling and regulation.

"Heating by Electricity at last Commercially Practical."

"The Ideal System which makes for Health, Cleanliness, and Economy."



"BUCKINGHAM."

PASTEL
PATENT
LUMINOUS LETTERS

The most Economical, Attractive, Artistic, and Novel System of Illuminated Advertisement . . .

PASTELS are the Cheapest, Best, and most Durable Method of Advertising.

ONE LETTER—ONE LAMP.

"This new invention brings the cost of the **most productive** form of Advertisement within the reach of all, and is strikingly attractive and a true eye-catcher."

"Advertising is to Business what Steam is to Machinery — the Grand Propelling Power."—*Lord Macaulay.*



"WINDSOR."

ELECOR
(NEW RADIUM)
LAMPS.

The Latest Development in Electric Lighting.
Gives Brilliant Light.
Perfect Distribution.
Extra Long Life.
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patents, that the system has been approved by important fire insurance companies, some of which have already given practical proof of their faith by installing the new electric heaters in their establishments. Although the "Pluto" was only recently introduced, the hygienic value was immediately recognised by the medical profession, especially in regard to its application for hospitals, sanatoria, &c., and the system has already secured the commendation of the technical and general press.

The advantages of equal distribution of a large area will readily be seen. The standards are finished in a neat and compact nickel sheath which does not deteriorate from the decorations. For heating conservatories, large halls, theatres, churches, &c., this special apparatus is ideal.

Another application of the "Pluto" system is that it can be carried round the walls of large halls, under the floors, in churches, &c., thus taking the place of hot water and steam pipes. The heat can be equally distributed over large areas and controlled for two or three temperatures from one point. This is accomplished by the "Pluto" Sectional Heater, about 8⅛in. by 2¾in. by 1½in. high. For running round the walls of large halls, &c., these sectional standards are placed end to end for any desired length. In fact, any combination, size, or shape can be readily constructed.

THE NEW RADIUM LAMP.

The new Radium Lamp, which was on view and much admired, surpasses all other productions of the kind in power, simplicity, economy, and cost. The lamp marks the very latest evolution in incandescent electric lighting. The many complaints as to the total of their electric light bills are simply due to lack of knowledge as to what is necessary for economical yet effective illumination. The advantages and features of the new Radium Lamp can easily be stated and easily grasped. First and foremost, they overcome the two principal drawbacks of large size glow lamps of high candle-power, viz., a concentrated staring "glare," and the irritating and confusing shadows which are set up in all directions. The new Radium Lamp is of spherical shape, and from a decorative point of view is a distinct improvement upon the old style "pear drop," but the practical results yielded by the lamp are, of course, first considered by the consumers. This lamp has been so devised that it remains comparatively cool whilst in operation. By special and ingenious construction it disseminates a soft and even light throughout, it is shadowless because of its power of universal diffusion. In this way the light is greatly increased, whilst the cost of consumption is decreased; in other words, the new Radium Lamp gives 25 candle-power, whilst consuming less current than an ordinary 16 candle-power lamp.

The Lamp is supplied with a small opal reflector, the angle and position of which has been most carefully determined in order to reflect the light transmitted through the clear part at the top of the globe without interfering with the "diffusion" from the rest of the lamp. Again, the lamp by reason of its size and special construction can claim a much longer life than any other lamp yet designed, whilst frequency of renewals is much diminished.

IMPORTANT TO MANUFACTURERS.—Makers of Electric Cranes, Hoists, Elevators, Cableways, Transporters, and Accessories, should read announcement on p. 412.

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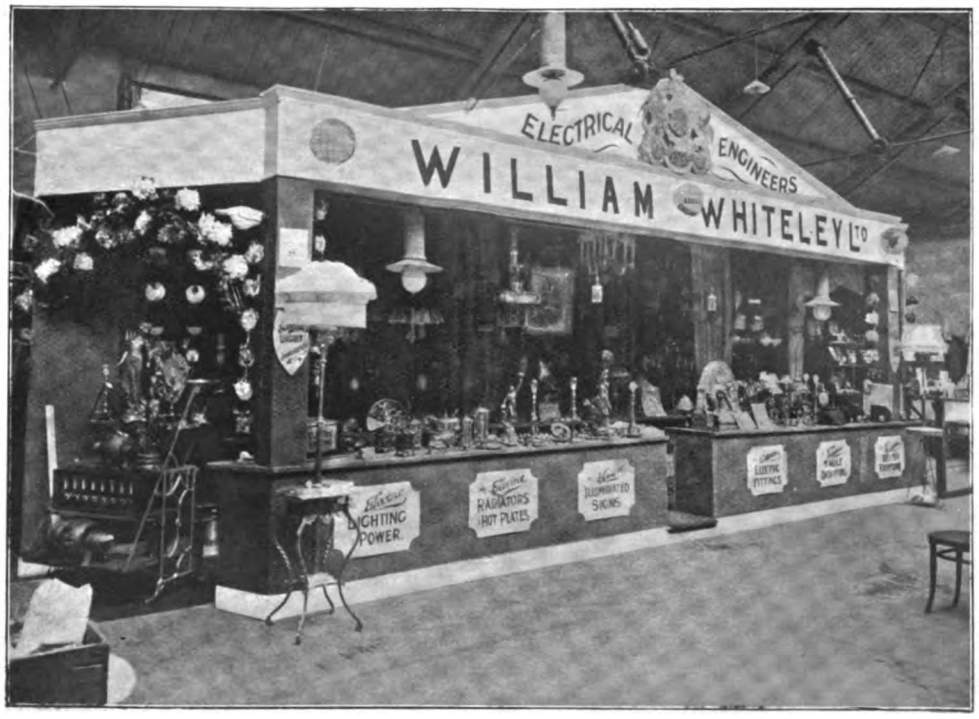
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THE EXHIBIT OF WILLIAM WHITELEY, LTD.

A HANDSOME and attractive stand was that of William Whiteley, Ltd., who, in their capacity as Universal Providers, are naturally electric light and power engineers. The accompanying illustration, though it in some measure represents the arrangement and decorative effect of the stand, does not convey a full idea of the handsome fittings and apparatus exhibited. A special effort had been made to attract the eye of the visitor with the elaborate and highly ornamental electroliers, wall brackets, stand and table lamps, and many-hued collection of shades; and judging by the patronage afforded the stand, the labours of the electrical engineers were amply rewarded.

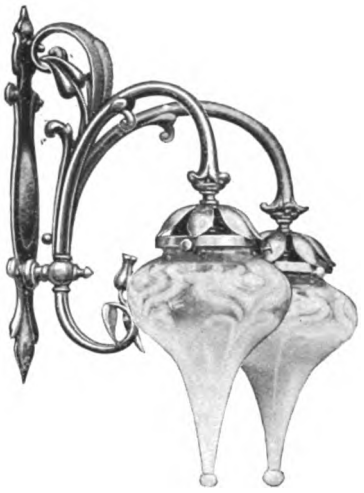
The exhibit included continuous-current motors and generators, the former being shown in both enclosed and open types. A number of enclosed arc lamps for series or parallel working on alternate or continuous-current circuits were also shown. Among these was a special form of twin-carbon lamp for connecting in parallel to existing 200-volt circuits. A good showing was made with illuminated signs and facias, there being several methods employed for giving different colours and arrangements of lights. In conjunction with these were the automatic controlling switches for bringing the groups of lamps in and out of circuit. Special arrangements of signs can be prepared, and as the firm has had considerable experience in this branch of lighting, its recommendations are a certain guarantee of economy in current and effective result in display. Considerable attention was attracted to the domestic heating devices on view. These are of a special kind, fitted with a reliable protection against damage in case of boiling dry. Large cooking utensils making considerable drafts of power on the circuits are supplied by separate mains from the lighting leads, but in cases where only a small demand is required, such as with curling irons, heaters, shaving pots, cigar lighters, and water jugs, these devices can be fitted with wall plugs to connect to sockets on the ordinary lighting mains.



THE STAND OF WILLIAM WHITELEY, LTD., AT THE PADDINGTON EXHIBITION.

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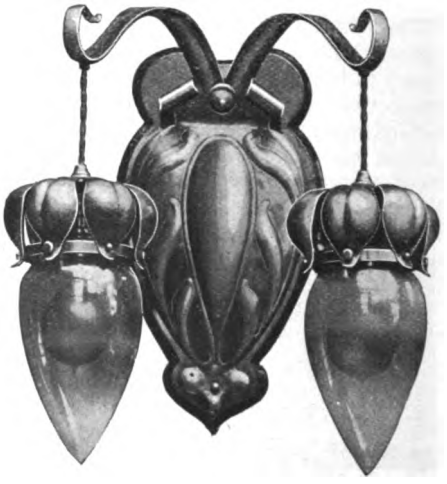
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SPECIAL TWO-LIGHT BRASS BRACKET.

Messrs. William Whiteley, Ltd., are contractors for very large installations of electric light, supplied either from local mains or from a separate plant. We shall refer to the latter later on. The methods of fixing the wires are of the best, ensuring complete immunity from fire, and when work is done in a first-class manner, under the supervision of reliable and trustworthy men, there is not the least fear of danger. The rules of the various insurance companies and the supply authorities, are strictly adhered to, consequently the work installed can at all times be regarded as absolutely safe.

In the matter of fitting private houses, mansions, and country residences, the firm has had exceptional experience, and in addition to providing good materials and workmanship in the running of the wires, they can give discreet advice regarding the selection of appropriate fittings to suitably match the surrounding furniture or decorations. Further, from their very extensive stock of electrical fittings, they can select designs to meet the most exacting tastes. Work of this character requires the attention of specialists, as, although a householder may have ideas as to the best fittings and the most pleasing accessories for his purpose, he cannot be expected to know the correct number of lights required for a maximum of artistic effect with a minimum of expense both in the installation itself and the current consumption of it when in service. For this reason the exhibit of Whiteley, Ltd., was particularly instructive, and it is to be hoped that visitors to the stand at the Paddington Electrical Exhibition will recollect that at the show rooms of the company an even more comprehensive collection of fittings and apparatus is constantly on view.



SPECIAL TWO-LIGHT FITTING.



TWO-LIGHT BRASS BRACKET.

For the installation of private plants in country districts or isolated situations, the company are quite as well equipped as they are for the fitting of residences situated within the confines of towns and cities where electricity is always on tap. For this work, either steam, gas, oil, or water power can be employed, and in each case the particular requirements can be readily met. William Whiteley, Ltd., employ engineers specially qualified for this branch of work, and may be relied upon to successfully instal plant with a minimum of delay to the customer and to his complete satisfaction when put into operation.

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OTHER ELECTRICAL EXHIBITORS.

ACCORDING to the Official Catalogue the Stands were numbered up to forty, a circumstance which testifies to the patronage of the Exhibition by various electrical firms. We are prevented by the limits of space from referring to these exhibits in detail.

R. Waygood & Co., Ltd., attracted many visitors with their working model electric passenger lift. They were also showing a hand-power dinner lift for private house use and lift accessories.

Verity's, Ltd., made a splendid show of dynamos, motors, blowers, and fans, while the stand was brilliantly lighted with their arc lamps. A great variety of fuses, switches, and shades, were also on view.

The Westminster Engineering Co., Ltd., make a speciality of arc lamps, particularly those types suitable for the interior and exterior of large shops. As might be expected, their stand was one of the luminous spots of the exhibition.

I. B. Blaiberg exhibited electric light fittings, art metal work, and a special line of hand-hammered fittings. The Company also contracts for complete power plants.

O. T. Banks & Co. made themselves known as specialists in temporary lights. The band-stand and outside lighting had been carried out by them with their patent lighting cable, and the artistic effect was excellent.

Palmer & Co. made an attractive show with their English electric light fittings, with an extra special line of the same in brass and copper.

The Hardy Patent Pick Co. received well-dese ved attention with their magnet.c seperator, a device which economically removes iron and steel from other metals and materials, and in the latter can be included destructor refuse.

James Keith & Blackman kept the air stirring with a number of their electric fans, two of which, 30" and 24" respectively, were driven by induction motors. This exhibit was well patronised.

Among the other representative firms we notice ***Elliott Bros., The Dowsing Radiant Heat Co., The British Westinghouse Co., The National Telephone Co.,*** and ***F. Sage & Co.***

Preliminary Announcement!

EXTRA DOUBLE NUMBER!!

The July Issue of the Electrical Magazine commences a new volume (the fourth), and it will be more than twice the size of the ordinary edition. Special features will be made of the following:—

The Municipal Electrical Association.
A fully illustrated Report of the Annual Meeting at Edinburgh, with papers and discussions.

The Electric Tramways and Railways Exhibition.
An extended descriptive account of the important exhibits and chief features of electrical interest.

The Municipal Tramways Association.
A complete record of meetings, papers, and discussions of this important Tramway body.

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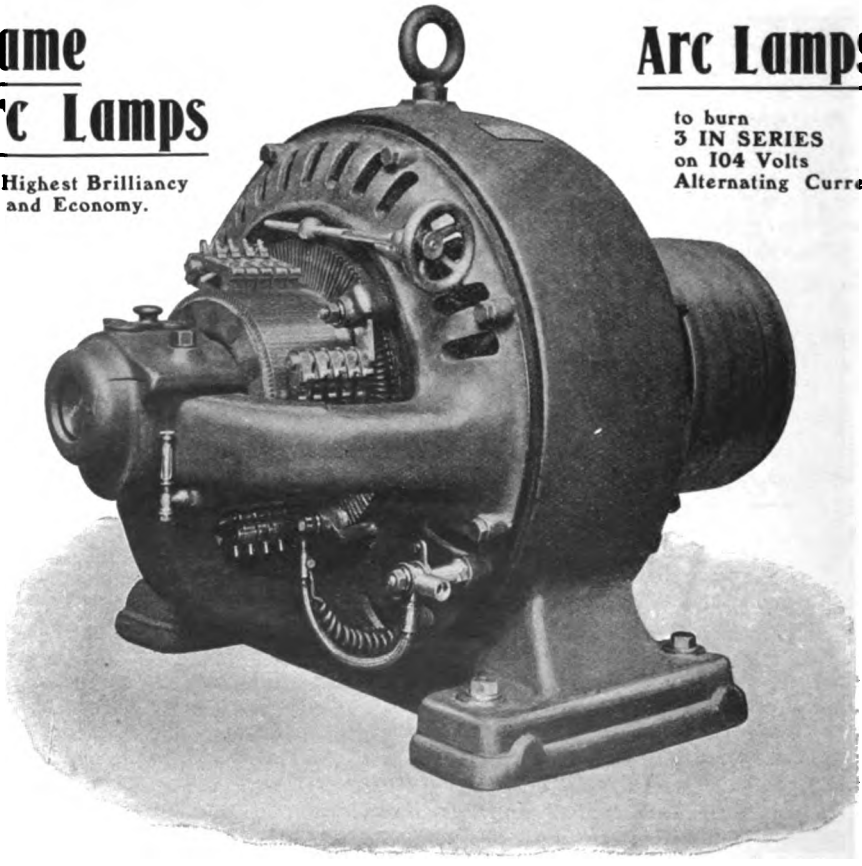
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THE INTERNATIONAL BUILDING TRADES EXHIBITION.

THIS exhibition, which was open from April 27th to May 6th at the Agricultural Hall, was naturally of sufficient importance to attract certain electrical firms whose business runs parallel to that of the building trades, consequently it was a matter for no surprise that makers of electric lifts, fans, hoists, and wiring accessories should figure in the official catalogue. On page 23 will be found a detailed description of a special exhibit, and below we furnish a few particulars of the apparatus shown by a number of representative firms.

C. Chancellor & Co. were showing a speciality in the shape of Velure and Stripso. These are special paints with remarkable spreading, elastic and weather resisting properties, and are suited for coating almost anything, whether subjected to steam, water, sun, or frost.

Medway Safety Lifts and Elevator Co. were showing electric passenger-lift gear, which is self-contained and controlled from a hand switch inside the car. The car can also be controlled by their push-button devices.

Other exhibitors of electric lifts were ***R. Harman & Co., J. Richmond & Co., R. Waygood & Co.***

James Keith & Blackman Co., Ltd., exhibited amongst their numerous specialities Blackman Electric Fans for continuous and alternating current, also their special system of intensified gas lighting.

Orenstein & Koppel showed portable railway track installation, steel tipping wagons, improved axle boxes and roller bearings, with and without springs.

R. W. Blackwell & Co. made a special exhibit of their rubberoid roofing and damp course. They also showed their giant insulating paper and electric conduit tube and fittings.

W. J. Burroughs & Sons displayed electric lighting appliances and motors for private house installations, in conjunction with heating apparatus and sanitary specialities.

Babcock and Wilcox were showing a model of their patent water-tube boiler, mechanical chain-grate stoker and turbine tube cleaner, together with a collection of photographs.

H. F. Joel & Co. exhibited their patent motors and dynamos, in which only one magnetising coil is used. Machines of from 1 to 10 h.p. were on view, these being suitable for pressure between 240 and 480 volts.

The Armaduct Manufacturing Co., Ltd., were in one of the gallery bays, and made a good display of wires, cables, armaduct conduit fittings, electric light fittings, and wiremen's sundries.

In the Surveyors' section ***Mr. W. H. Harling*** was much in evidence with his excellent cases of drawing instruments and surveying instruments.

The Horsfall Destructor Co., Ltd., showed the complete ironwork for a destructor furnace, and working models of their patent dust catcher and direct cart-fed furnace.

Meldrum Bros., Ltd., showed models of their patent refuse destructors and patent furnaces for steam boilers. Also specimens of destructor clinker and clinker products.

A large selection of photographs of installations and an electric lantern exhibition showing plants installed were attractive features.

Heenan & Froude, Ltd., who are extensive makers of refuse destructors and mechanical draught plant for power purposes were also represented.

The importance of safety from fire in building construction is now fully recognised and was well emphasised in the exhibits of numerous fire-proofing firms, among whom we may mention the British Fire Proof Construction Co., the Stonwood Fire Proof Flooring Co., The Excelsior and Phœnix Fire Resisting Partition and Ceiling Co., The Colombia Fire Proofing Co., and the Acton Concrete Partition Co.

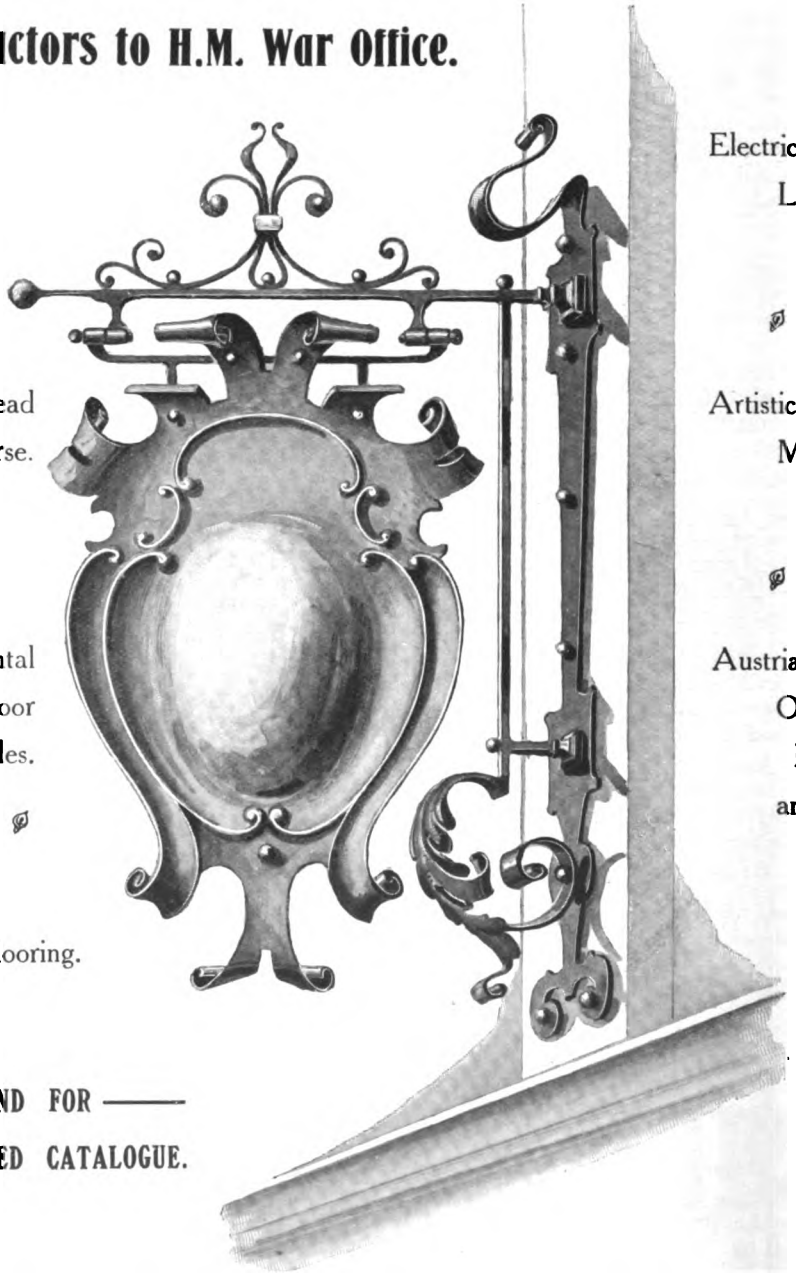
Do not forget next month—Special Electrical Transport Supplement.

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Telegrams: Erdkreis, London. **Telephone: 2294 Gerrard.**

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Contractors to H.M. War Office.



Asphalted Sheet Lead Damp Course.

Plain and Ornamental Wall and Floor Tiles.

"Durato" Flooring.

Electric Light Fittings.

Artistic Metal Work.

Austrian Oak Panelling and Joinery.

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An Italian Roof Garden for London.

AN innovation in the treatment of open spaces, which will be of special interest to everyone connected with machinery halls and electrical installation, is being carried out at the Westminster Electric Lighting Corporation Station in Duke Street, Grosvenor Square, London, from designs and under the supervision of Stanley Peach, Esq., F.R.I.B.A. Permission has been obtained for the Corporation to excavate under an existing open space, and this they have done to the depth of about 30 ft., constructing a very capacious machinery hall. Over the building, which is run up some 8 ft. above the level of the roadway, a very handsome Italian Roof Garden is being constructed. This is approached from the footway by flights of steps at either side of a monumental pavilion at each end. It was necessary to prevent any damp percolating through from the garden to the electrical machinery beneath, and the work in connection with this has been entrusted to Messrs. Hofler, Limited, who were exhibiting at the Agricultural Hall an interesting model of the structure.

They are laying over the concrete screeding their Patent Asphalted Sheet Lead damp course, which is composed of two layers of asphalte with a layer of sheet lead between, the material being lapped over about 3 in., forming a 6-fold interleaved joint, the whole being given afterwards a coating of volcanic cement. The damp course is then floated in cement, and covered with tiles in geometrical design. The whole, when completed, with its handsome stone balustrading, benches, and centre fountain, will give a very pleasing and artistic effect. Our illustration represents the work of laying the damp course in operation. It has been largely used on the Continent for many years, but only recently has it been introduced by Messrs. Hofler on the London market.

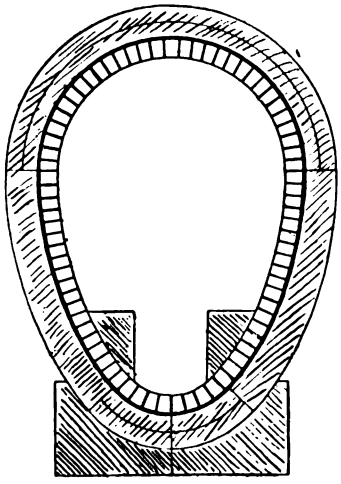
The illustrations on the next page indicate the manner in which this material is particularly well adaptable for subterranean and railway work, and in all instances where cables have to be carried under ground. This damp course can be used either vertically or horizontally. In using it on the foundations of buildings a very great saving of labour is effected, as this material being made in rolls in all wall widths (that is to say 4½in., 9in, 13½in., and so on) any labourer can unroll it along the foundations, and to those interested it would be advisable to write to 26a, Soho Square, for Messrs. Hofler's illustrated sheet descriptive of the many uses and advantages of this Asphalted Sheet Lead. Messrs. Hofler also make a speciality of a very hard and non-absorbent tile most suitable for factories and engine rooms, of which they are laying a large quantity in conjunction with the Asphalted Sheet Lead damp course.

Another important department with this firm is their "Durato" flooring, which, although practically new to England, has been used in large quantities on the Continent. This material is laid cold over wood or concrete, and is guaranteed not to crack or work, as so many of these so called fireproof floorings have done in the past. It gives an agreeable "grip" to the feet, is warm and non-absorbent, and can be swilled down with water, or waxed and brushed to a high polish. In addition to being a very durable flooring for factories, it is most suitable for hospitals, sanatoriums, and public buildings where cleanliness and the absence of any crevices or joints (which would form



LAYING DAMP COURSE.

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THE THICKER LINE REPRESENTS ASPHALTED SHEET LEAD DAMP COURSE. COMPLETE INSULATION FROM DAMP FOR ELECTRIC CABLE CHANNELS, &C.

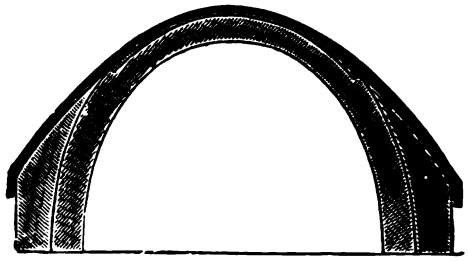
a likely bed for the accumulation of any germs or bacteria) are essential.

A great advantage with this floor is that it has stood the test of time, large quanties having been used on the Continent, consequently Messrs. Hofler are in a position to guarantee that it is all that they represent it to be.

A very extensive department in connection with Messrs. Hofler's is that for electric light fittings, of which they have a very quaint and varied assortment to special and original designs not to be seen elsewhere. Their smithies are situate at No. 13, Berners Mews, where, if necessary, the work can be supervised during its construction. They also undertake every description of artistic wrought iron work, such as lift enclosures, staircases, balustradings, balconies, signs, dog grates, fenders and fire irons, door furniture, &c., &c.

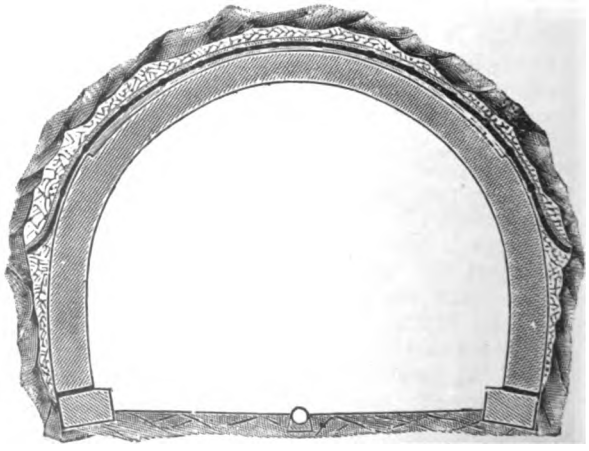
Their department for Austrian oak panelling and joinery work is also well worthy of inspection by anyone interested in the decoration of dining rooms, billiard rooms, staircases, offices and showroom fittings, and they have some very clever prints illustrative of the important contracts they have been entrusted with under some of the most eminent London architects, such work already executed being, after all, the best reference that can be had as to the facilities this firm possess for carrying out the work in a satisfactory manner.

Their factories are situate in Austria, and at 8, Berners Mews. At the latter address a competent staff of joiners are employed for fixing the panelling and joinery work, on its arrival. A large proportion of the work is also, where time will not permit the transit, made in London.



FOR COVERING HORIZONTAL AND INCLINED SURFACES, SUCH AS BRIDGES, TUNNELS, VAULTS, UNDERGROUND PASSAGES, &C., &C.

In conclusion we can strongly recommend our readers to pay Messrs. Hoflers a visit and inspect the many novelties they have in their specialities at their showrooms, 26a, Soho Square. They are Contractors to the War Office, and issue a very neat and artistic catalogue containing illustrations of the more important works they have executed, and embodying a fuller description of their work than it is possible to give in a notice of this description.



FOR TUNNELS, SUBWAYS, &C.

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Electrical Transport : its Development and Possibilities.

HAD space permitted we should much have liked in the introduction to the present Supplement to have given a descriptive history of the rise of electrical transport devices. Failing this, we will briefly refer to the industrial importance of this branch of electrical engineering.

Great Britain has for many decades been the centre of great activity with steam and hydraulic power. These two agencies commanded all attention, and the devices translating their energies into various forms of useful work have consequently become highly efficient in practice. Precedents thus established could not be easily swept aside, and the British engineer has by force of circumstances been hampered with types of machinery which advanced experience in other countries has for some time proved to be inadequate and inefficient. His Continental and American confrères, unrestricted by such limitations, and with a wider field of enterprise, have been able to forge ahead of him in the production and utilization of electric cranes, conveyors, hoists, lifts, &c. In spite of the lead thus gained, the British maker has now become fully alive to the possibilities of electric power in this extensive province. He has been materially assisted by the increase in the sources of electrical energy, the demand for which in the operating field has similarly created a market for electrically-driven apparatus.

The current Supplement indicates in a striking manner the activity of British engineers in the production of electrical transporting apparatus. The firms represented do not, it is true, make up the sum total of Britain's workers in this direction; in fact, more than three times the number have been approached during the collection and preparation of the matter for the Supplement. We say without hesitation that any loss which this country experienced through a too long adherence to steam and hydraulic power for operating the machines referred to above has been fully recovered since definite action was taken to adopt modern methods. There is not the least necessity to go beyond the borders of our shores for an electric crane, transporter, conveyor, or the like kind of machine. Germany and America have perhaps anticipated us in realising and putting into practical effect electrically operated transporting apparatus, but we in our turn, backed by a substantial and unique engineering experience, are enabled to turn this to good account in utilising the electric power which we have for so long apparently feigned to despise

In introducing so important a subject we cannot but dwell on a few of its engineering and economical aspects. Unlike its rival power producers, the electromotor can be operated in any position and without regard to the conditions of its surroundings. It is as safe amid the dust of a coal conveyor as it is reliable at the weather-exposed head of an elevator. On grounds of economy, it is "streets ahead" of its competitors, for the simple reason that the power which it consumes is almost directly proportionate to the work it is called upon to do. As compared with the hydraulic crane, for instance, the electric type is fully 25 per cent. more efficient, but this comparison relates only to full load conditions. Throughout a very wide range the efficiency of the electric crane varies but little, certainly not more than 10 per cent., but the hydraulic form is most efficient at full load, at any point below which its economical performance falls rapidly away.

Needless to say, electrical transporting devices have long since passed the experimental stage. Manufacturers have arranged definite standard lines for the several types required in everyday practice, while they are fully prepared to design and manufacture for any special class of work. The commerce of the world to-day, with its amazingly quick deliveries of materials collected from the ends of the earth, owes its triumphs of expedition to electric power.

In this country, the entire face of industrial labour is being changed, and where grimy steam and sloppy water once reigned supreme, the magic of the electromotor is spreading its influence, saving the valuable physical energies of man, and conducting, under his control, work which would otherwise be accomplished only by a system but little removed from slavery, or never at all.

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THE WIDNES-RUNCORN TRANSPORTER BRIDGE.



THE opening of the transporter bridge across the Mersey at Widnes and Runcorn is a triumph for electricity, and should be generally recognised as such. Only by the aid of electric power could the idea of moving a travelling cradle suspended by steel ropes from a similarly suspended track have been realised, as no other known power—steam, gas, water, or air—could have been applied with the same effect and economy. Again, it must be remembered that the materialisation of this project in its present form reduces the cost of the bridge to a very low figure in comparison with a suspended roadway or a steel structure. The generation of the necessary power also minimises the cost of each journey, and when we say that this is accomplished at the rate of 1d. per trip, the amount appears astoundingly trifling in comparison with the work done.

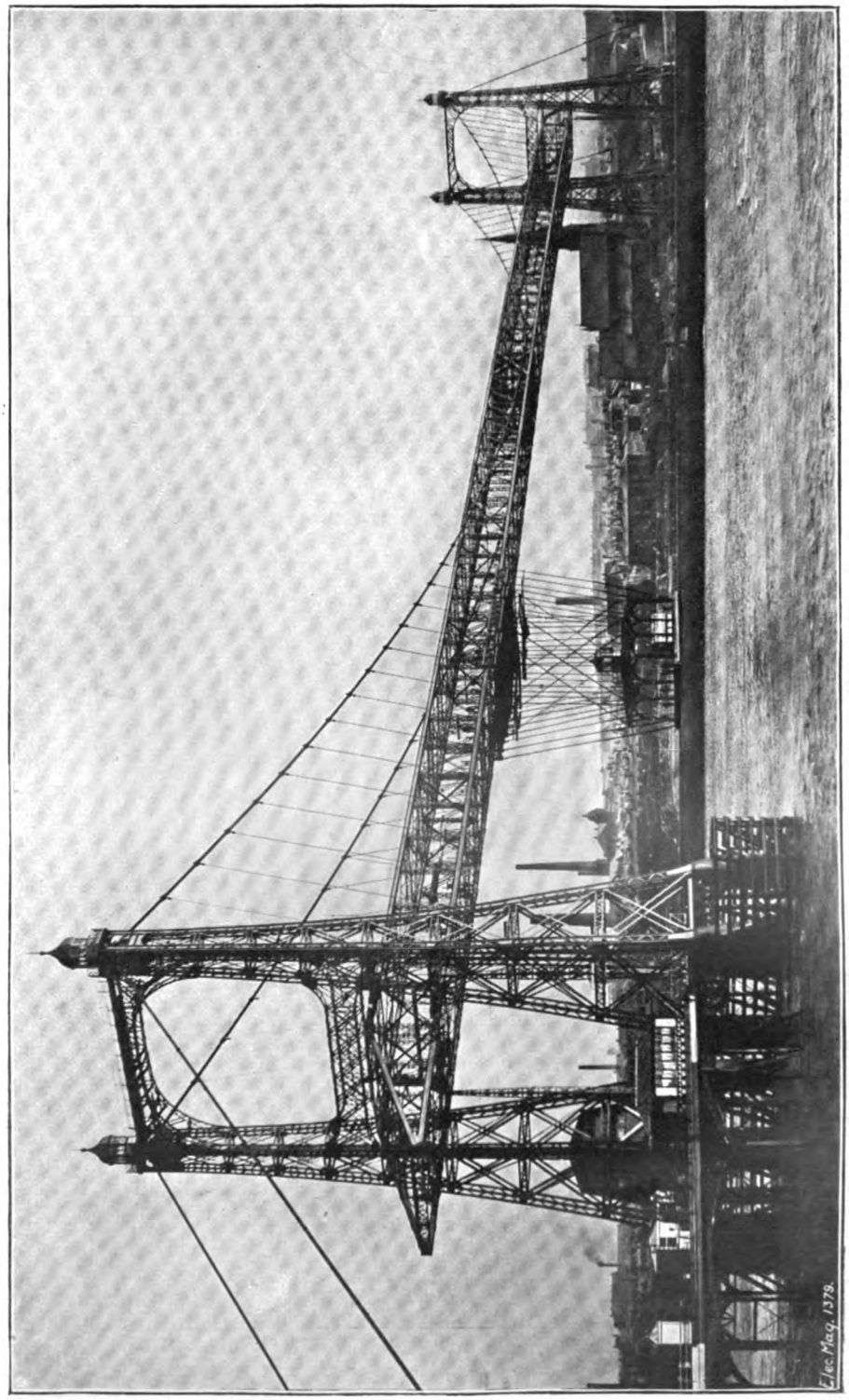
We give illustrations of the bridge, the traveller, the driving motors, and the power plant, all of which, though self-explanatory, bring up the proportions of the structure and the details of its power equipment. Rock foundations on each side of the river support double steel towers of ornamental design rising some 200ft. above water level. Stretched across the 1000ft. span are two monster steel cables, 1ft. in diameter, anchored on each bank behind the towers. The towers are connected by stiffened steel girder work, which is suspended by smaller cables from the main span. This forms the track on which runs the traveller holding up the car. The traveller itself is 77ft. long and is fitted with 16 wheels on each side, two 35 h.p. direct-current motors serving to



WIDNES AND RUNCORN TRANSPORTER CAR IN MOTION (CONTROLLING HOUSE AT TOP OF CAR).

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Widnes-Runcorn Electrical Transporter Bridge.

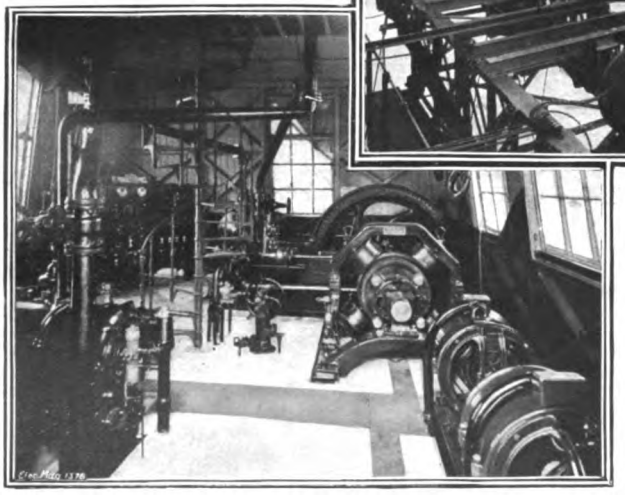


Span, 1,000ft. Car capacity, 300 passengers, 4 wagons. Journey occupies 2½ mins. Each crossing costs 1d. for power.

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drive it across the bridge. The control is effected from a cabin surmounting the transporter car, as will be noticed in the illustrations. The car has a capacity of 300 foot passengers and four two-horse vehicles, and will make the crossing in a little over two minutes.

The contractors for the electrical equipment were Messrs. Mather and Platt, Manchester, who have had extensive experience in this field, supplying the plant for two swing bridges over the River Weaver and the rolling bascule bridge at Barking. They have also supplied and erected the generating plant and the lamps for the lighting of the bridge. The power plant is gas driven, there being two 75 b.h.p. Crossley gas engines direct-coupled to Mather and Platt 48kw. dynamos. The engines run at 210 revs. per min., and current is supplied at 525 volts. A battery of 245 Chloride cells is provided, and in conjunction with it is a booster for use during charging.



POWER HOUSE, SHOWING ONE OF THE GAS DYNAMOS AND BOOSTER.

In the corner of the engine room is the switchboard, arranged with three panels : one for the dynamos with the necessary main and regulating switches and measuring instruments ; the second for the accumulator cells and booster, similarly fitted up ; and the third for the feeding and lighting circuits.

From the switchboard two supply cables are led up the tower and across on to the main girders of the bridge, where they are attached to two overhead T-shaped conductors carried by insulators below the cross girders of the bridge, and from which the current is collected by trolley arms, and thence passes down to the controlling



VIEW ABOVE THE TRAVELLER, SHOWING MOTORS AND GEARING.

apparatus in the driver's cabin, placed on the top of the transporter car. The motors are of Messrs. Mather and Platt's steel-clad entirely-enclosed type, and are each capable of developing 35 b.h.p. when supplied with current at a pressure of 500 volts ; they drive by means of gearing and shafts the two driving wheels of the trolleys, and are arranged also to act as brakes for stopping the car. The control cabin also contains a small switchboard, with the requisite switches and instruments for the information of the driver.

We are indebted to Messrs. Webster and Wood, the consulting engineers, for the loan of the photos on pages 2 and 3.

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SEE PAGES 545-549 AND 554 OF THIS ISSUE.

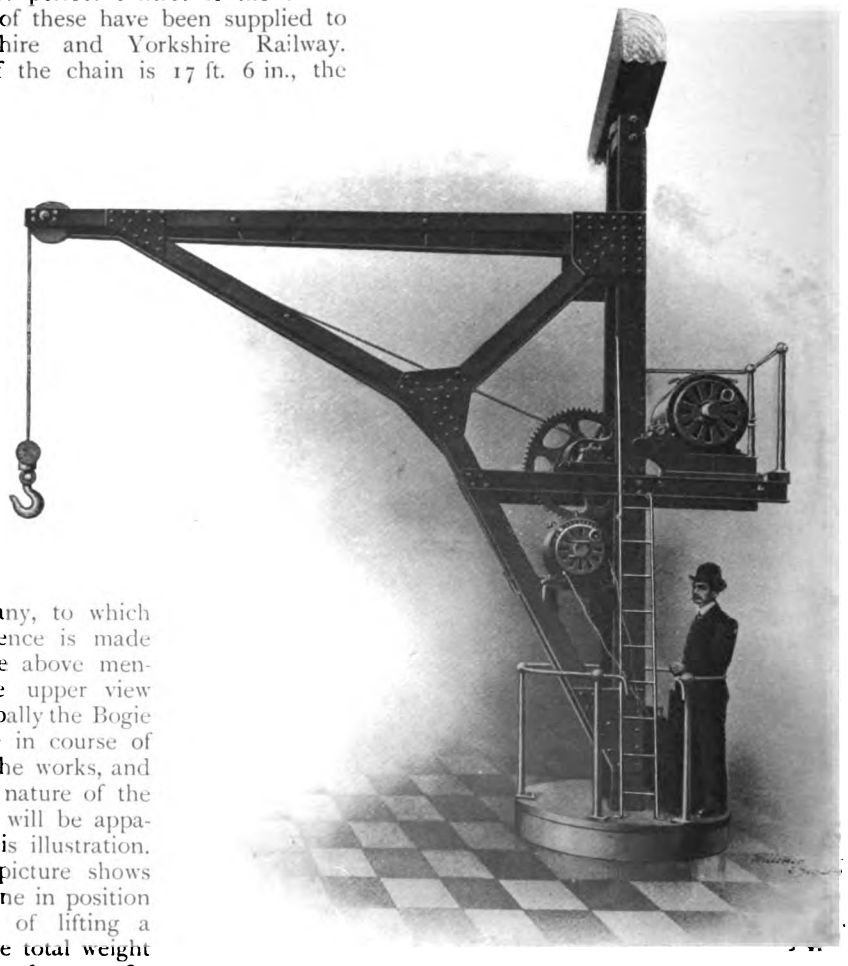
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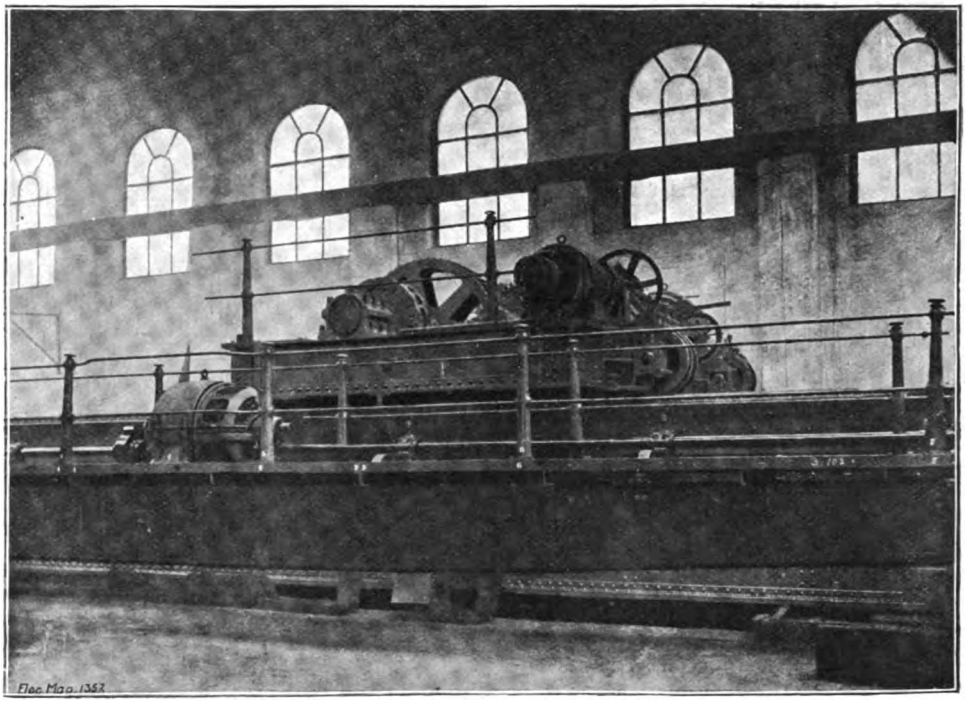
SOME CRANE SPECIALITIES OF MESSRS. THOS. BROADBENT & SONS, LTD.

WE cannot do better than open the notices in our special Electrical Transport Supplement by referring to the specialities of Messrs. Thos. Broadbent & Sons, Ltd. A fully illustrated description of the large works of this company will be found in "Manufacturing Progress" this month. We illustrate on this page a special form of warehouse crane which will be found exceptionally convenient for its purpose. It will be seen that each motion is driven by a separate motor, and for this reason the attendant has perfect control of the crane. Twenty-one of these have been supplied to the Lancashire and Yorkshire Railway. The rake of the chain is 17 ft. 6 in., the hoisting speed 50 ft. per minute, and the slewing speed 250ft. per minute. The total capacity of the crane is 2½ tons. On the opposite page is shown a large crane supplied to the Ebbw Vale Steel, Iron and Coal Company, to which special reference is made in the article above mentioned. The upper view shows principally the Bogie of the crane in course of erection at the works, and the massive nature of the lifting-chains will be apparent from this illustration. The lower picture shows the same crane in position in the act of lifting a converter, the total weight of which is 106 tons. In addition to many important achievements in electrical transport work which have made the name of Broadbent one to be conjured with in the crane world, we may mention that an order has just been received from Sir W. G. Armstrong, Whitworth & Company, Elswick, for a 40-ton 4-motor crane, the thirtieth crane supplied to the company by Messrs. Broadbent. Also there are passing through the works at present five 10-ton and one 20-ton cranes for the Patent Shaft and Axle Tree Company, Wednesbury, and many other orders.



BROADBENT'S 2½-TON ELECTRICALLY-DRIVEN FIXED WAREHOUSE CRANE.

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100-TON 6-MOTOR CRANE, IN COURSE OF CONSTRUCTION IN MESSRS. BROADBENT'S WORKS.



100-TON 6-MOTOR CRANE IN USE AT THE WORKS OF THE EBBW VALE STEEL, IRON AND COAL COMPANY, LIMITED.

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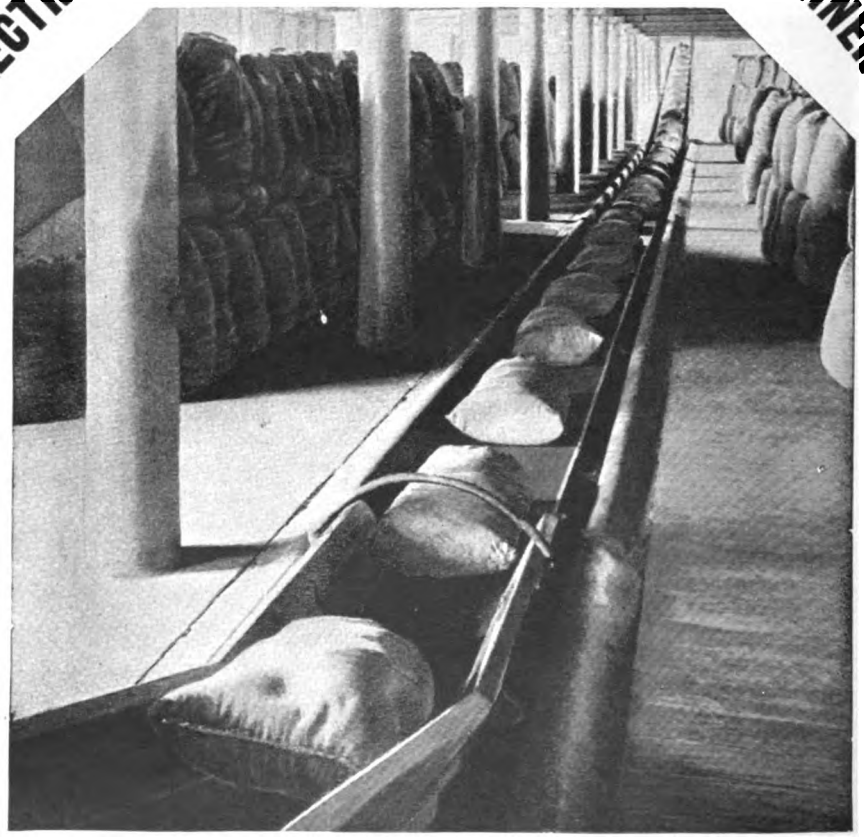
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MODERN ELECTRIC CONVEYING PLANT.

ONE of our most up-to-date and enterprising firms is that of Messrs. Spencer & Company, Limited, Melksham, Wilts, whose extensive new works we recently had an opportunity of inspecting, and were so much impressed thereby that we hope in the near future to make them the subject of an exhaustive illustrated article.

Messrs. Spencer are well known as the leading specialists in grain-handling machinery, and we recommend everyone who is at all interested in this class of work to write to them for a copy of their new illustrated handbook, in which they will find full particulars of many of the largest installations of this kind carried out in this country. Messrs. Spencer were amongst the first British firms to thoroughly appreciate the advantages offered by the electric motor as a source of power, and for many years past the great bulk of the elevating and conveying plants designed and manufactured by them have been arranged for electric drive. At the present time, they inform us that it is quite a rare thing for them to apply any other form of motive energy. In most cases, of course, the requisite current supply can be obtained from some public source, but in large plants it often pays to put down a private generating station, and many complete driving plants of this description have been installed by the Melksham firm in connection with their contracts.

The applications of handling and transporting appliances to grain are so varied and numerous that in our limited space we can only illustrate one or two typical examples. Fig. 1 shows one of Messrs. Spencer's electric travelling elevators for discharging grain in bulk from barges or small vessels. The whole of the elevating, also the travelling, is controlled by one electric motor so arranged that one man can work the entire plant. The grain is delivered to a band-conveyor running along the gantry, and from thence is taken by means of a system of fixed elevators and band-conveyors to any desired part of the store. By this means the grain is entirely discharged and stored without the intervention of manual labour, and the work is done at a fraction of the cost and in a fraction of the time required by old-fashioned methods. Wheat, maize, barley, oats, linseed, cotton seed, &c., can all be dealt with with equal convenience.

Grain or flour in sacks can also be mechanically handled by means of band-conveyors, and many very extensive plants

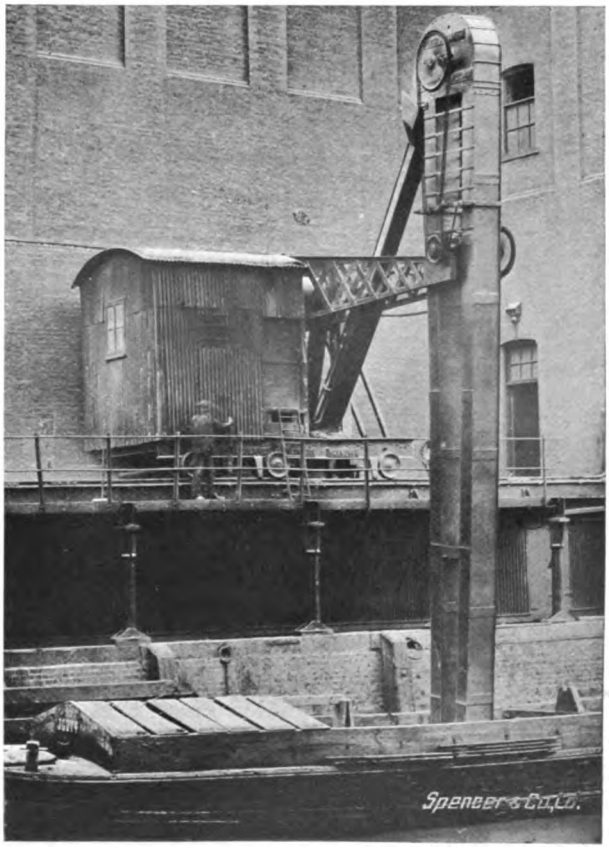


FIG. 1. ELECTRIC TRAVELLING BARGE ELEVATOR AT HULL.

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patent elevators at work in the hold of a vessel at Avonmouth Docks. This also is electrically driven, and is arranged to travel along the quay. It has been so successful in that position that another similar elevator has been ordered by the Docks Committee, and will be used at their Docks at Bristol.

Messrs. Stothert and Pitt specialise in all kinds of hydraulic appliances for the handling and discharging of cargo, and supply complete sets of machinery for all the above purposes in any part of the world.



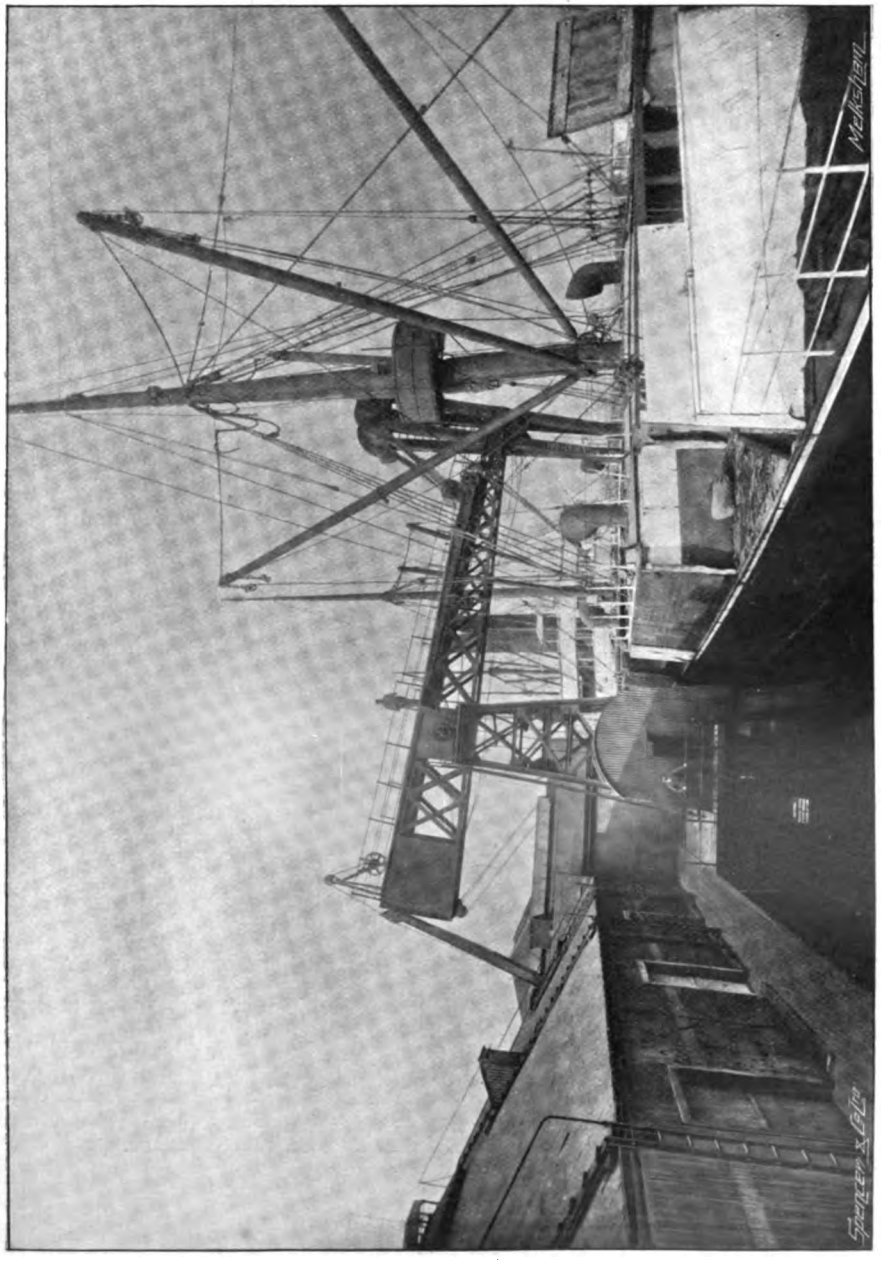


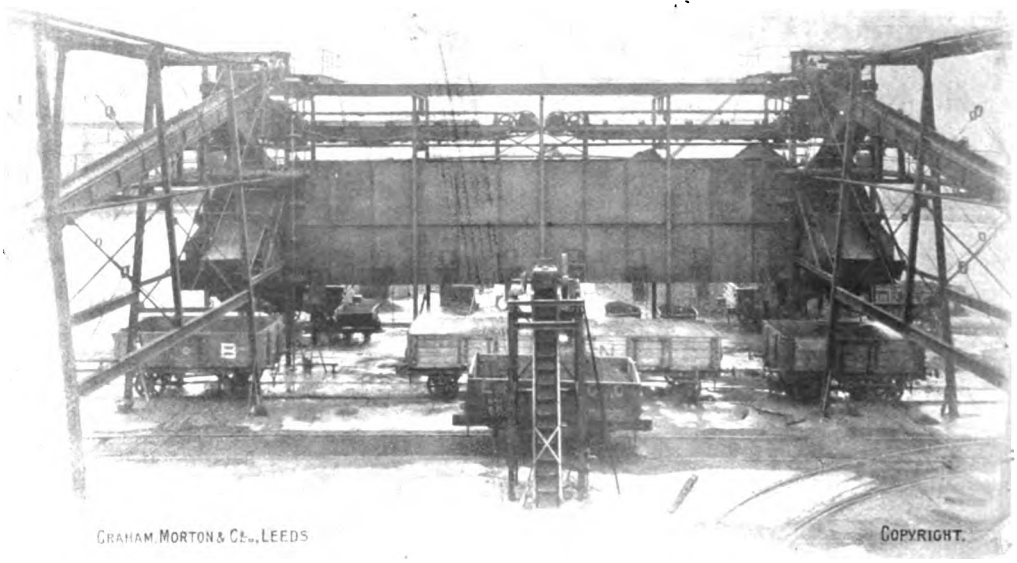
FIG. 3. ELECTRIC SHIP-DISCHARGING ELEVATOR, ERECTED BY SPENCER & CO., LTD., AT AVONMOUTH DOCKS.

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AN ELECTRICALLY DRIVEN COAL CONVEYING AND SCREENING PLANT.

MANY achievements have been made in the application of electric driving to various classes of plants, but it is quite a new departure to have an entirely electrically driven screening plant, together with the automatic transport of the coal tubs from pit mouth to the Screening Plant. The plant in question is for effectually screening the coal (5,000 tons per day of ten hours), produced from the two pit shafts of the Dean and Chapter Colliery of Messrs. Bolckow Vaughan & Co. Ltd., Middlesbrough. Probably such a large screening plant was never installed at one time. The plant consists essentially of :—

(1). The motor driven creepers for bringing automatically the tubs from the two pit banks to the screens, and we might mention that during the transport the tubs are weighed, so that the contents of each wagon is registered.

(2) The automatic tipplers, five in number, which as soon as the tub enters commences to work, and completely turning the tub over at a steady rate allows the contents of the same to be discharged down the shute on to the jigging screens, the latter separating the large from the small coal. The large afterwards passes on the respective picking belt of each screen, here to have whatever foreign matter is found taken out.

Underneath the floor of the Screen House, placed in a convenient position, is a Conveyor for taking away all refuse picked or sorted out of the coal, and so as to make even this automatic, the refuse is elevated to a suitable height, and discharged into a self-emptying bunker.

Everything is motor driven, and the entire plant has been arranged so that the motors are in duplicate, with the additional advantage of each section of the plant being easily coupled to another section in the event of a breakdown, or to another source of power should any motor give out. The contractors for the entire work are the firm of Graham, Morton & Co., Ltd., whose record in constructing their own works will not be forgotten.



ELECTRIC SCREENING AND CONVEYING PLANT. DEAN AND CHAPTER PIT

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Temperley Patent Transporter at West Ham Electricity Works.
Length of Beam, 314 ft. Load, 35 cwt.
EXTERIOR.



Temperley Patent Transporter at West Ham Electricity Works.
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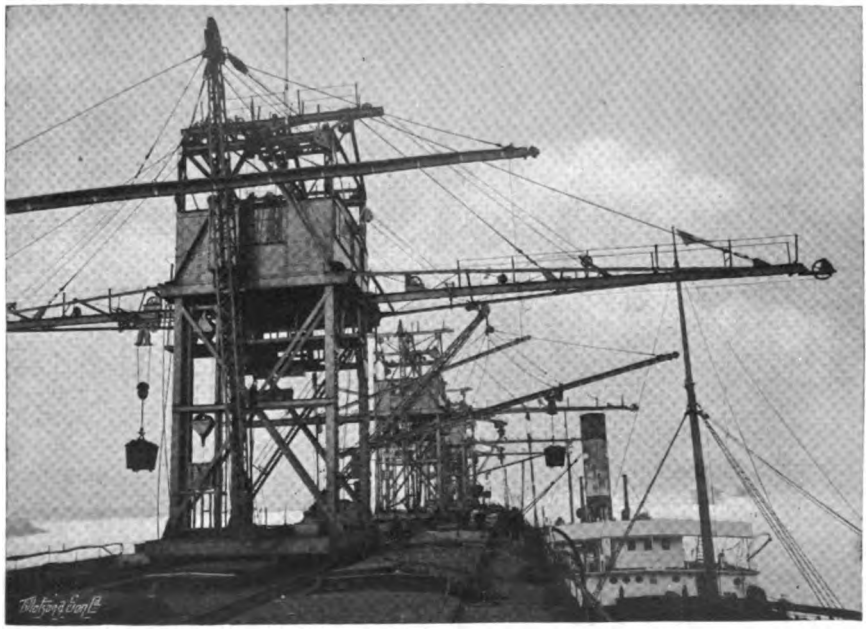
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ELECTRICAL TRANSPORTING DEVICES.

ALTHOUGH steam is used for the operation of lifting and conveying machinery, electric power is pre-eminently suited for this class of work. This is particularly evident in the special apparatus of the Temperley Transporter Company, whose devices are to be met with everywhere both ashore and afloat. They meet the requirements of almost every condition of working in this province, such as unloading and discharging vessels, and handling material in bulk at wharves, railway sheds, warehouses, electricity supply stations, &c. In the majority of these places electric power is always "on tap," consequently it is only natural that the highly efficient and economical electromotor should be employed for operating the various motions of the transporter. The transporter proper is simplicity itself, comprising an automatic traveller, a beam forming the track upon which the traveller runs, a steel rope for lifting and transporting the load, and some form of hoisting engine for operating the rope. The travellers are arranged for either inclined or horizontal tracks, and the operations of lifting, transporting, lowering, and dumping the load are performed by the simple action of hauling in and paying out a single rope. When the load is being lifted the traveller is automatically locked to the beam. When the load reaches the traveller the latter takes the weight, is automatically unlocked from the beam and runs along until the dumping point is reached. The rope is then paid out and the load lowered, the traveller again locking itself to the beam. This simple transporting unit can be attached to a travelling tower for running along a dock side or in a yard, or it can be fixed in any desired position and in any building. It can also be mounted on a central pivot, and operate through any desired radius. Special coaling craft can also be provided with the transporter units.

The transporters are largely used in electricity works, notably at the Metropolitan Electric Supply Company's Willesden power house, West Ham Electricity Works, the London Electric Supply Company's Station, Deptford, Hornsey District Council power house, &c. A large permanent staff of engineers is employed by the company, specially trained and experienced in lifting and transporting machinery.



TEMPERLEY TRANSPORTER COMPANY'S PATENT FLOATING COAL DEPÔT 12,000 TONS CAPACITY

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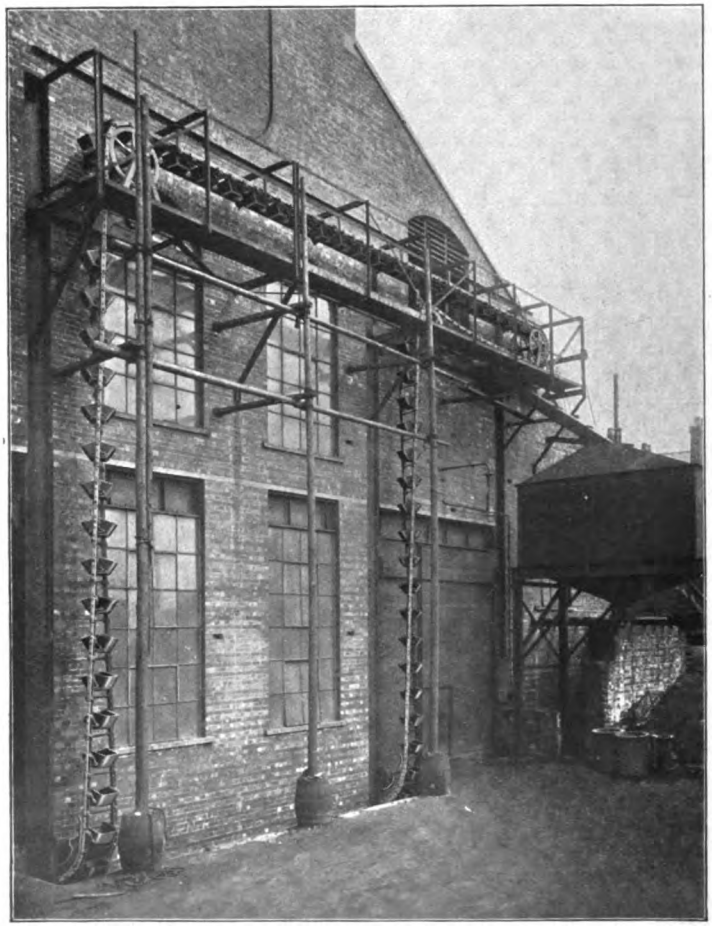
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OLDHAM ELECTRICITY WORKS.—Ash Conveyor, having a capacity of 20 Tons per Hour.
The above Illustration shows the Flexibility of the Conveyor in the Vertical Plane.

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COAL HANDLING PLANT.

Babcock & Wilcox, Limited.

IT is now becoming an axiom amongst progressive engineers that if economical conditions are to be maintained, obsolete methods of handling coal must be discarded, and full advantage taken of the modern and mechanical methods which the past few years have developed, and by which very great saving is effected. An important factor in this step has been the cheap and easy application of electric motive power to almost any class or kind of work.

The steamship, freight train, barge, etc., has taken the place of the horse and cart, and one man, by means of suitable mechanism, can control loads in hundreds of tons of material, instead of in tons. As a natural sequence the further handling of this material should be on a correspondingly large and efficient scale. The Babcock and Wilcox Gravity Bucket Conveyors and kindred plants are eminently designed with this object, and quantities from 15 tons per hour to 80 tons can be economically delivered by single machines overhead, ready to be used to the best advantage, and at a cost which appears ridiculously insignificant when compared with the old and wasteful processes which have so long held sway. The many orders placed with Babcock and Wilcox, Limited, for Coal Handling Plants during the past year clearly indicate that the principle is becoming better understood, and economy seriously studied.

When it is considered that say, 100,000 tons of coal or other material must be handled per annum, costing by obsolete methods 1/- per ton, or a total of £5,000, the saving which can be effected when this cost is reduced to say 1d. per ton is very striking. The Conveyors are balanced, and consequently require an expenditure of power only sufficient to overcome the friction of moving parts, plus the power required to raise a certain weight of material a given height in a given time. This is in strong contrast to methods of handling necessitating the use of heavy and unbalanced tubs, skips, &c., usually weighing as much or more than the actual load contained by them. The continuous method is also superior to the alternating, as shocks due to change of direction are avoided, and silent working, small friction, durability, and freedom from repairs, are some of the results. These Conveyors, unless damaged by wilful neglect, continue to give the most satisfactory results through years of constant use, repairs being almost unknown. They have been applied largely in electric power stations at home and abroad, also in gas works for coal and coke, cement works, dockyards, &c., and are giving universally good results, as many repeat orders testify, many being installed with Babcock & Wilcox boilers of the marine type where the latter are used on land.

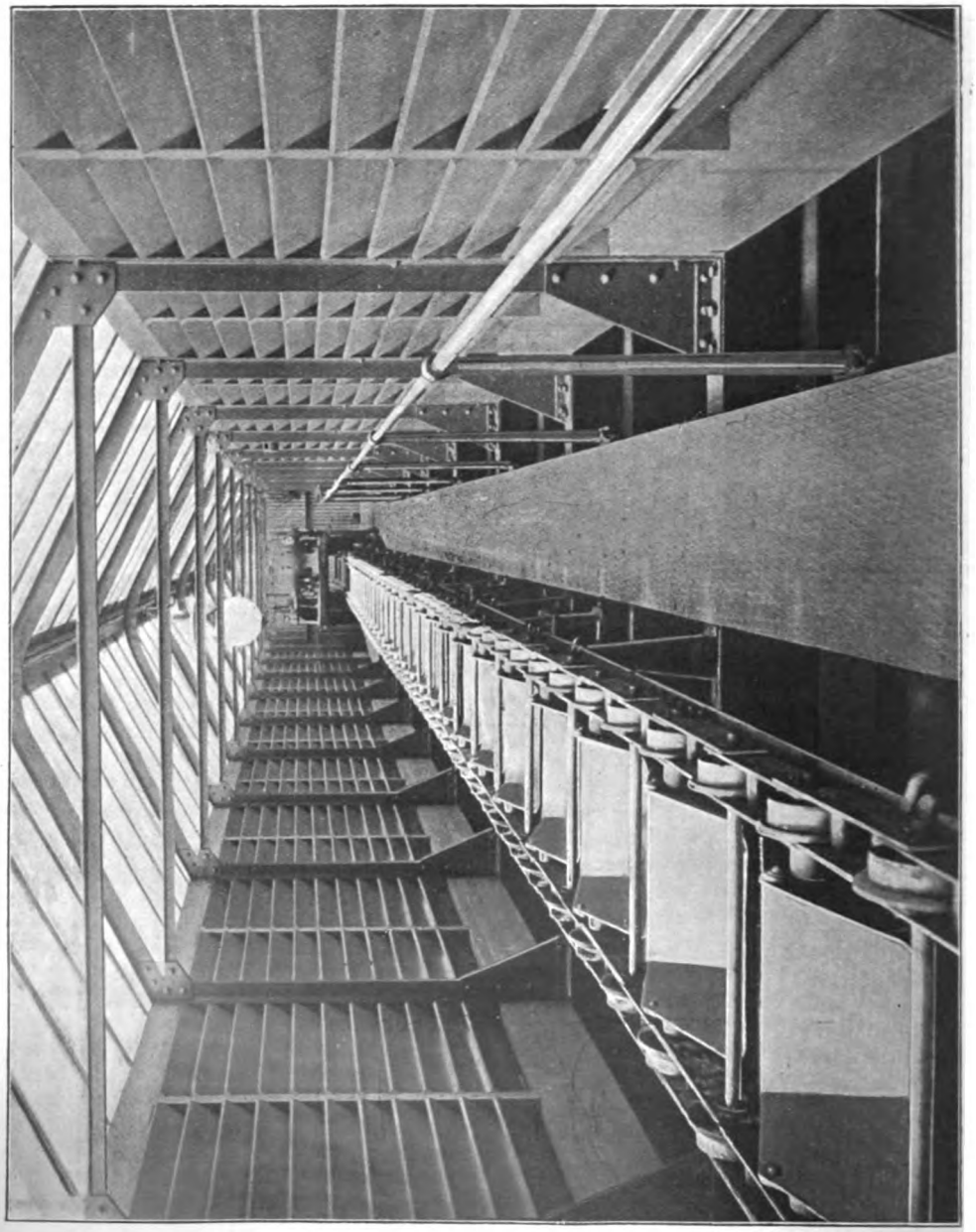
Tray Conveyors.

This is a type of conveyor admirably suited for handling materials when delivered in a constant or varying stream, when the same has to be delivered in one place or receptacle even if that point should be considerably higher than the point of receipt. This is an adaptation of the gravity bucket chain, wheels, axles, &c., to the continuous type of conveyor, lipped or flanged edged trays being substituted for gravity buckets, the trays forming an elastic steel belt on which the materials carried can be delivered continuously or intermittently, and then carried to the delivery end of the conveyor and dumped. This tray conveyor is extremely easily driven, one brake horse power being sufficient to operate 315 lineal feet of chain and buckets, the power has been tested on different occasions electrically.

Automatic Oiler.

A special Automatic Lubricator has been specially designed to supply, at the necessary intervals, sufficient oil to thoroughly lubrictae the chain, links, and wheels, and is equally applicable to the gravity bucket and the tray conveyors. This overcomes the difficulty and loss of time necessitated in hand oiling and supplies the oil in certain quantities, never missing links as in hand oiling, and assuring a certain and sufficient supply on the exact spot. The saving of time can be best realised when a conveyor of say 500ft. is to be oiled in all its joints, say 4,000, by one or two men with hand oilers, against the Auto-lubricator, oiling all the joints automatically as the chain moves. Any filtered waste lubricating oil is suitable.

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Babcock and Wilcox Patent Conveyor, Having a Capacity of 40 Tons of Coal per Hour.

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PUSH-BUTTON ELECTRIC LIFTS.

At the invitation of Messrs. William Sprowson & Co., of Ascendent Works, Manchester, we recently had an opportunity of examining their latest production in electric lifts, which consists of a type on the push-button system. The extent to which they have carried this system is, in our opinion, quite a unique achievement, and as decided a step in advance of the ordinary electric lift as electric lifts generally are in advance of hydraulic.

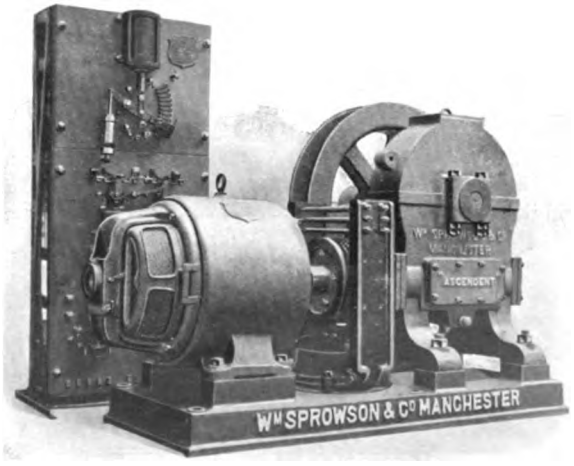
The lift we visited is in operation at one of the largest and busiest warehouses in Manchester, viz., Messrs. Joshua Hoyle & Sons, Ltd., Piccadilly, and is giving every satisfaction. One important feature of the lift is that no attendant is employed to work it, therefore a saving on working costs is effected to the extent of some £52 per annum.

To call the lift it is only necessary to press a button provided on each landing for the purpose. Buttons are also provided in the cage, numbered to correspond with the floors in the building, and to reach a desired floor it is simply necessary to press the corresponding button.

We enquired whether the makers considered such a lift to be as safe in the hands of the public as an ordinary lift in the hands of a skilled attendant. In reply, we were assured that it is safer, as in a lift which has to be worked by the public, safeguard against accident must of necessity be provided under every conceivable circumstance. This has been done, and it is impossible for the public to meet with an accident on this type of machine should they even seek to do so, and without such endeavour it is absolutely impossible. We understand that arrangements have been made with a first-class insurance company for indemnity against personal injury for passengers in this type of lift at premiums 40 per cent. lower than the same indemnity for passengers in any other kind of lift.

The next special feature we noticed was the speed at which the lift was travelling; this we ascertained to be at a rate of 230ft. per minute. It will be readily understood by the readers of this journal that for a lift to travel at a high speed under varying loads must present numerous difficulties in stopping accurately and automatically at floor levels. In an ordinary electric lift travelling at the same speed worked by an attendant it would be necessary to switch the current off at points ranging from, say, 3ft. to 1ft. before the cage approached the floor line, in proportion to the load which was in the cage, in order to stop it at the required level. Messrs. William Sprowson & Co.'s push-button lift, however, will stop at the floor level automatically whatever the load may be, notwithstanding the high speed named above. This achievement is effected by a special compound braking arrangement. The first is a brake of the ordinary friction type, applied as the circuit is broken by the demagnetisation of the brake solenoid. The secondary brake is a patent device of a purely electrical nature—details of which we are asked not to enter into in this article—and comes into operation as the cage reaches required level, resulting in immediate stoppage.

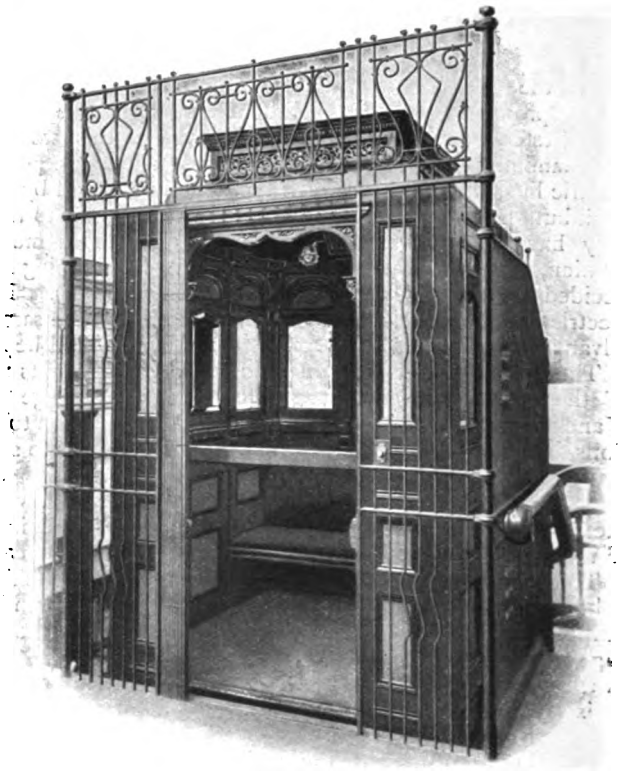
Another factor of safety to passengers is



COMPLETE LIFT GEAR WITH MAGNETIC CONTROL OPERATED BY PUSH-BUTTONS ON THE CAR.

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provided by the introduction of a patent electric safety bar. This bar—like the well-known patent bar gripper which is used on rope-operated lifts—is pivoted on one side of the entrance of the cage, and must be lowered to complete the circuit through the bar switch, to which it is connected, before the lift can be moved by a passenger in the cage; this forms an excellent protection to passengers travelling; and should they attempt to leave the cage while it is travelling it would be necessary to raise the bar, thereby immediately stopping the lift. The lift can only be controlled by the buttons on the landings when there are no passengers in the cage, but it can be worked from the landings whether the electric safety bar in the cage is up or down; this is an important point, as it is unnecessary for a passenger to lower the bar on leaving the cage.



PUSH-BUTTON LIFT, SHOWING CAGE WITH SAFETY BAR.

All push-buttons, both inside the cage and on the landings, are inoperative when any gate is open. The gates are provided with a patent automatic closing apparatus, so that immediately a passenger leaves the cage the gates close and the lift is ready again for any intending passenger. No gate can be opened until the automatic locking gear is released, which is done by the cage when it is at the floor level only. As the cage leaves the floor the gates are again automatically locked.

The accompanying figure shows the motor, control and winding gear, which—in view of the achievement it attains in its multiplicity of automatic movements—is extremely neat. The space occupied is about 6ft. by 4ft., at the same time the machine presents a design of the most substantial type, giving an observer the impression that it was built with the all-important end in view that nothing must be sacrificed to ensure the safety of the passengers. This is more essential in lift engineering than in other branch, and the result is strength and safety par excellence.

Upon enquiry of the manufacturers as to the cost of running their electric lifts, they informed us that they have received a letter from a consulting engineer, who was instructed to make some tests with this end in view stating the result to be twenty one return journeys for one penny.

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ERNEST SCOTT AND MOUNTAIN, LTD.

MESSRS. Ernest Scott and Mountain, Ltd., of Newcastle-upon-Tyne, whose new works at Gateshead our special representative visited recently, and describes in another portion of this paper, have perhaps done more work than any other firm of manufacturers in the United Kingdom for the transmission of power by electricity in mines and collieries. They were one of the pioneer firms to adopt electricity for driving pumps, haulage gears, coal-cutters, &c., underground, and have recently made some mining pumps for main shaft pumping to deliver against heads up to 2000ft.

As this supplement deals more with electrical transport, it will be better to state what Messrs. Scott and Mountain have done in this direction, the question of electrical pumping being held over for a future date. The firm make a speciality of electric traction and transmission machinery both for above and below ground, and in connection with overhead conveyors they have carried out several important contracts, including overhead conveyors for Sir John Jackson, Ltd., and also for Sir Douglas Fox and Partners in connection with the Zambesi bridge, &c.

For colliery work underground, Messrs. Scott and Mountain have played a great part in bringing to the front the conveying and bringing to bank of the produce of mines and collieries, and have carried out an enormous number of important contracts, thus proving that electricity can be well adapted for this purpose. It will be of interest to our readers to know that at one colliery in North Wales where they installed two sets of endless rope haulage gears, each gear being driven by an electric motor of 150 h.p., and dealing with three different roads, the owners were so well satisfied with the economical results that they decided to put down a similar gear at one of their other collieries, this latter gear being constructed to deal with three independent roads and being driven by a motor of 200 h.p., the current for this motor being conveyed by overhead cables from the power station at the first colliery. The results were again so satisfactory and economical that the owners have since decided to adopt electricity for pumping, coal cutting, &c.

Messrs. Scott and Mountain have also made and supplied some electrically-driven winding gears both for main shaft winding and also for winding in staples, and when our representative was at their works he saw winding and haulage gears of every description, both completed and in course of construction. Besides making machinery for drawing coals along the main roads Messrs. Scott and Mountain have made several gears for drawing coals from the in-bye workings to the main roads, where the main haulage takes up the train and brings it to the shaft bottom for bringing to bank.

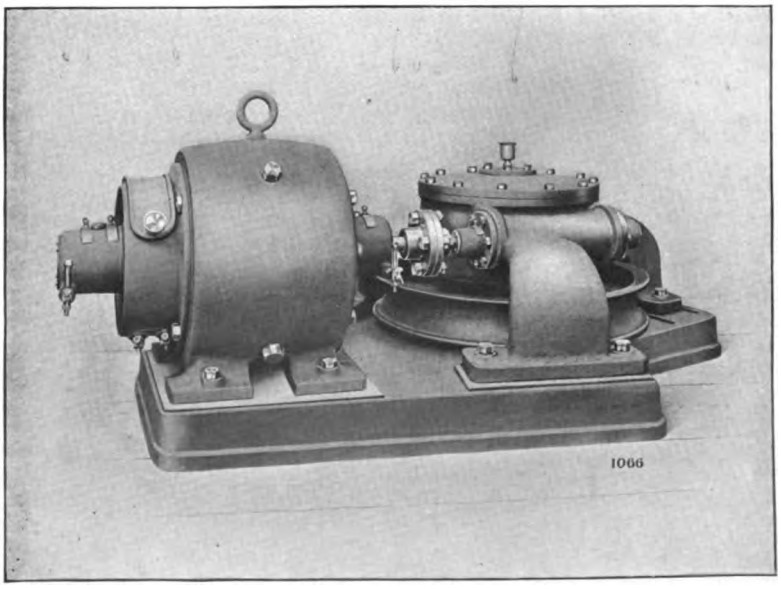


FIG. 1. SCOTT AND MOUNTAIN ELECTRIC ENDLESS ROPE HAULAGE.

The accompanying illustrations will speak for themselves, and show the class of machinery whcih Messrs.

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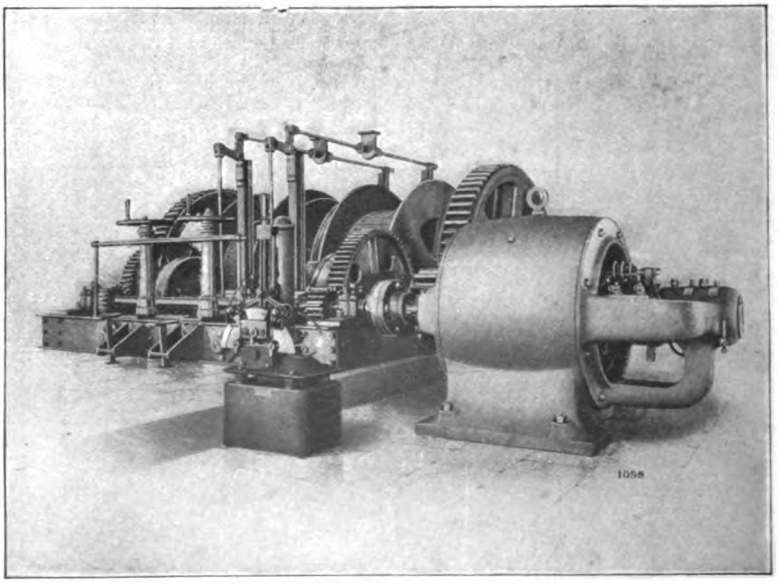
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Scott and Mountain manufacture. Space will not permit of a very lengthy article, but several instances could be given where electrical machinery has been made and installed in place of the old method of horse and steam haulage underground. One or two instances might, however, be given. Fig. 1 shows a very handy type of endless rope haulage made by the firm with horizontal rope wheel, this gear being worm-driven from the electric motor, and arranged for a speed of 2 miles per hour.

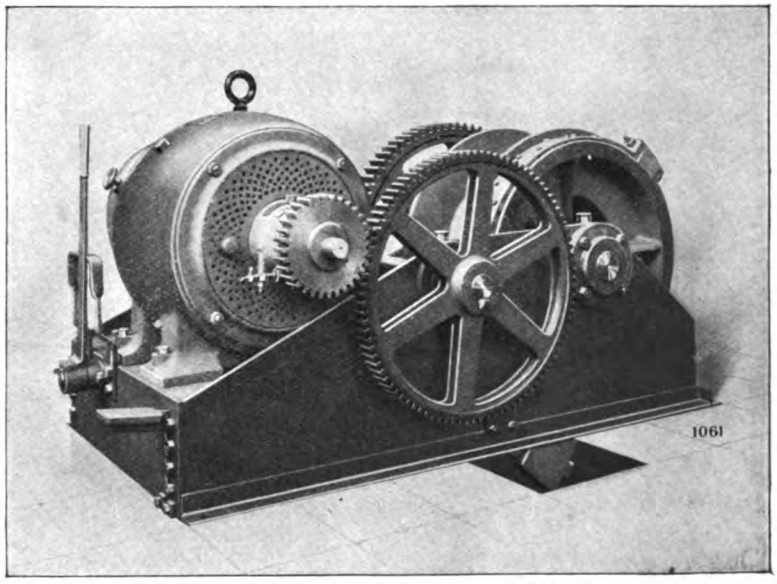


FIG 2. 20 H.P. SINGLE-DRUM ELECTRIC HAULAGE GEAR.

Another illustration is that shown in Fig. 2 of a 20 h.p. single drum haulage gear with machine cut spur wheels, this gear being arranged for a speed of 5 miles per hour, but similar gears have been made for speeds of 7, 8, and 10 miles per hour. The arrangement of clutch gear on these haulages is such that the drum can run loose on the shaft for letting the empty tubs run down the incline, thus saving wear and tear on the electric motor. Fig. 3 illustrates a main and tail haulage gear with spur wheel drive, which is recommended for sizes up to 20-30 h.p. In the near future we hope to deal more fully with the electrical transmission of power in collieries, and will then be able to illustrate and describe some of the large pumps, winding gears, &c., which Messrs. Scott and Mountain specialise.

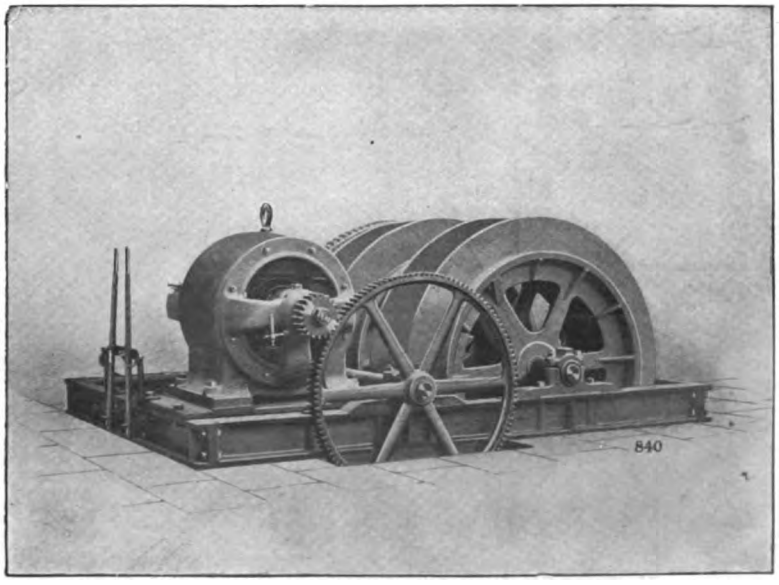


FIG. 3. MAIN AND TAIL HAULAGE GEAR

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ELECTRIC HAULING FOR MINES.

Messrs. M. B. WILD & CO.'S SPECIALITIES.

IN no branch of transport work is the electric hauling gear more essential than in the workings of mines. The relative advantages of either electric and steam or compressed air hauling plants has been discussed *ad nauseam* to the undoubted advantage of the former. Consequently, lengthy reference to the subject is quite unnecessary. At the same time, something more than admission of this superiority is needed. The mine owner may recognise in his mind the improvements in machinery which are brought by advancing research and still retain his antediluvian plant with its consequent inefficiency and reduction of earnings. This lethargic attitude must, however, be broken down, and tentative recognition must give place to unqualified practical support of modern devices for mining operations. In this respect the electric hauling plant cannot be overlooked. It compels attention for various reasons. It is compact, efficient, safe, reliable, and economical. It requires no special supervision, and the driving motor will run for extended periods without attention.

Messrs. M. B. Wild and Co., of 35 and 36, Clarence Chambers, Corporation Street, Birmingham, specialise in electric hauling gears and have supplied a considerable number for every class of haulage work. Fig. 1 illustrates a 20 b.h.p. single drum gear mounted on wheels and axles which are arranged for use either on road or rail. It will be seen that this is a very compact device, and by reason of its portability it can be used just where the work it required. In special cases the point from which the hauling goes on requires to be constantly shifted, and with a portable plant the removing of the holding down tackle permits of the conveyance of the entire gear to the next selected position. The sphere of utility of this class of gear is accordingly not confined to collieries but extends also to brick yards, clay pits, steel works, and quarries. For certain kinds of building work it would also prove valuable and be much more portable than a steam plant of equal output.

Figs. 2 and 3 illustrate the arrangement of the 25 b.h.p. self-contained double drum haulage gear—main and tail rope—with driving motor tramway type reversing controller and resistances. The speed of the motor can be regulated by a 90° of normal speed, and the motor will start up against full load. To withstand very rough usage and frequent overloads the motors are specially wound, their design being based on special experience with hauling machinery. The first motion gear wheel consists of machine moulded wheels with double helical teeth, and the second motion is a machine cut spur wheel with raw hide pinion keyed on the shaft. The gears can be fitted with direct current or polyphase motors. The gears are made in all sizes, to meet requirements, special or otherwise, from 5 b.h.p. upwards. The gear bed is built up of steel girders, strongly braced together. The drums are assembled on mild steel plates and steel angles, and are specially strengthened. Powerful brakes operated by foot levers are fitted with ratchets for pinning down the brakes, and in

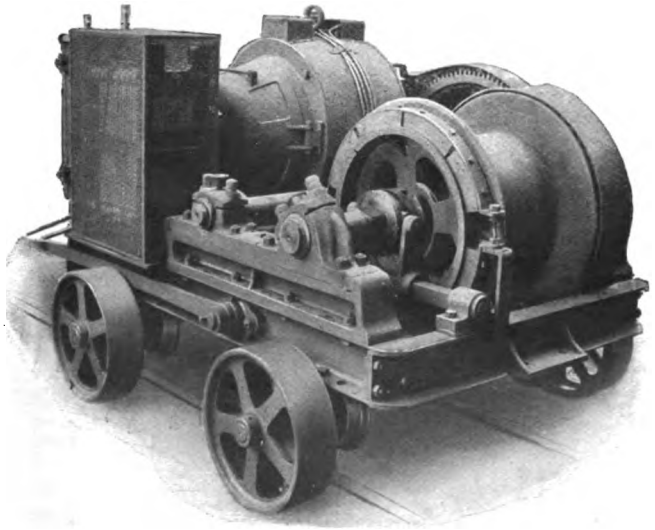


FIG. 1. 20 B.H.P. PORTABLE HAULING GEAR.
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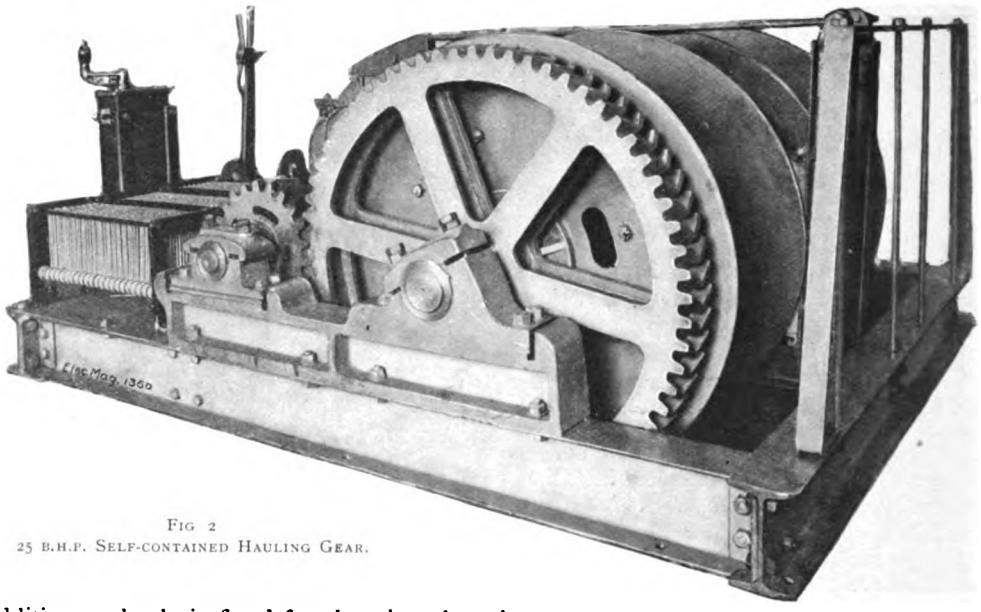


FIG 2
25 B.H.P. SELF-CONTAINED HAULING GEAR.

addition a clutch is fitted for throwing the drum in and out of gear, this being operated by two short levers, one long lever placed conveniently near the controller.

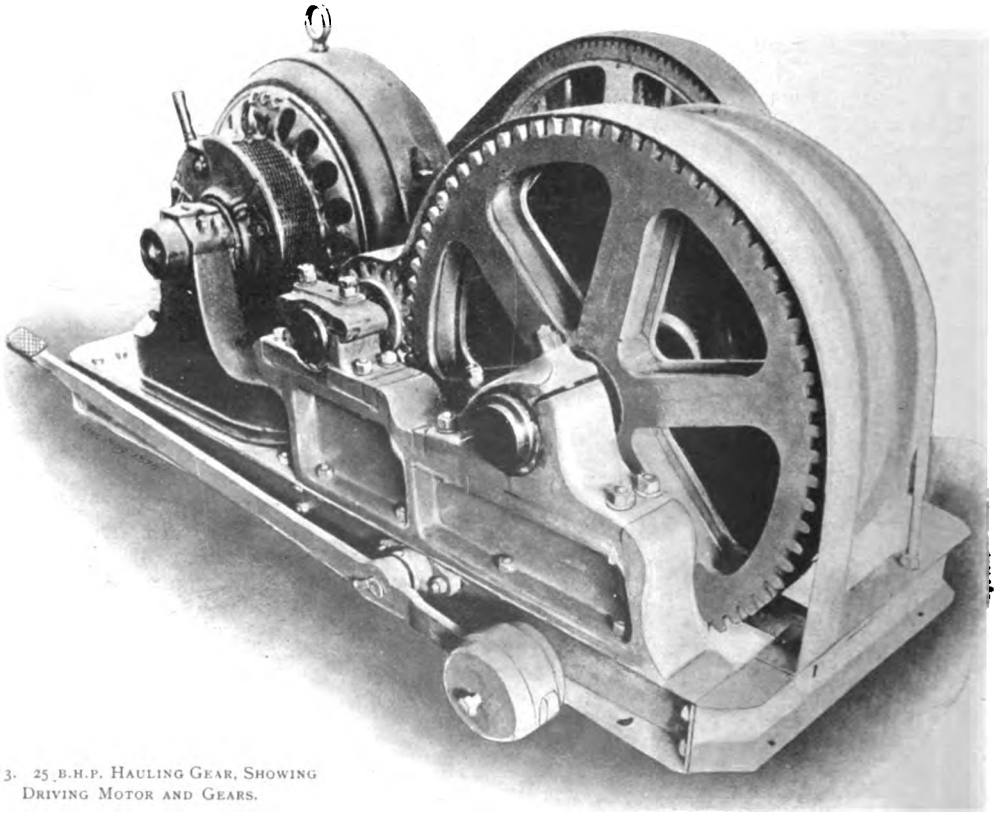


FIG. 3. 25 B.H.P. HAULING GEAR, SHOWING DRIVING MOTOR AND GEARS.

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SILVERTOWN ELECTRIC HOISTS.

STANDARDISATION is an important feature in electrical transport machinery as there are so many designs of apparatus to which the electro-motor requires to be fitted, and with as little modification as possible. It enables quick delivery to be guaranteed if the motor and its drive can be taken out of stock, and, moreover, the renewal of parts becomes a mere matter of replacing interchangeable parts. For certain class of transporting apparatus, such as hoists, lifts, gears, capstans, and winches, the worm drive from the motor to the winding drum permits of a common method of operation being fixed for each particular type of gear, the adaptations to each case being of the simplest possible kind.

With this end in view, the India Rubber, Gutta Percha and Telegraph Works Co., Ltd., Silvertown, Essex, have specialised a line of electric hoists, winding gears, and capstans, in which a standard worm drive has been adopted. The motor, brake gear, worm, and worm wheel are practically the same for electric hoist, capstan, winch, or in fact for any form of motion in which a speed reduction is required from the motor shaft. The worm drive has been made the subject of special study, and upwards of forty motors are fitted at the Silvertown works with this form of drive, the output ranging from 3 to 150 h.p. For this reason the extensive experience thus gained lends particular value to the design, embodied in the electric winches, hoists, &c., now manufactured by the firm.

Fig. 1 illustrates a Silvertown Standard Electric Hoist, to lift 7cwt through 300ft. in one minute. The motor is series wound as a quick acceleration was wanted, and also a high speed with lighter loads, and is capable of developing 12 b.h.p., at a speed of 450 r.p.m. The motor is of the standard totally enclosed Silvertown type, and the gear is similar to that which has been adopted for hoisting gears, lifts, and cranes. The motor carries a steel worm on an extension of its shaft, which gears with a phosphor

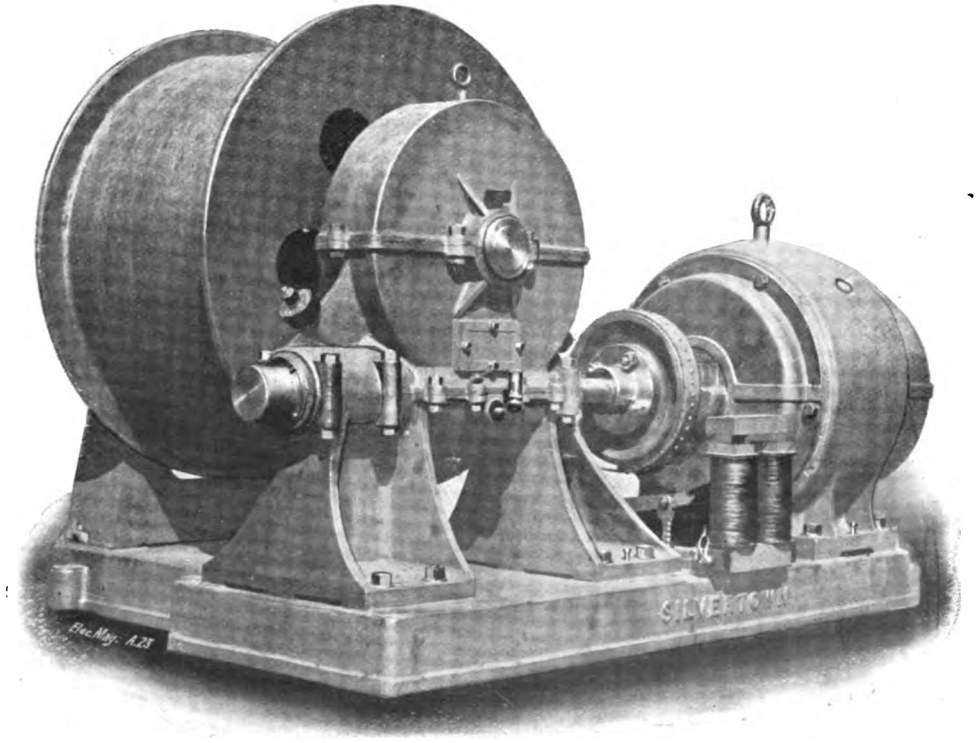


FIG. 1. SILVERTOWN ELECTRIC HOIST, AS SUPPLIED TO WEST AUSTRALIAN MINES

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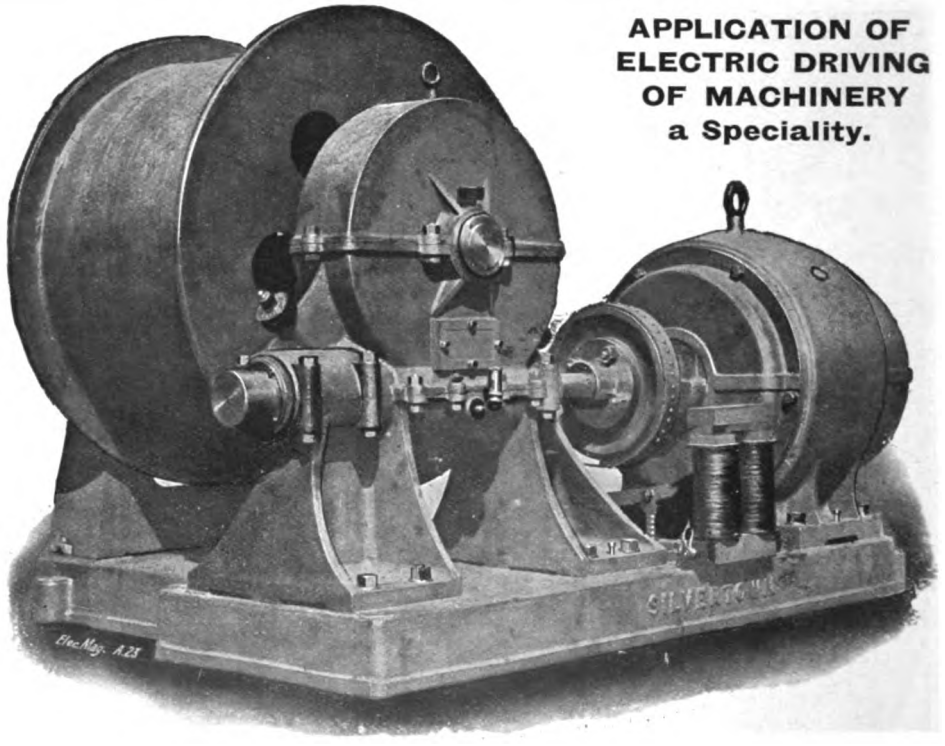
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bronze worm wheel on the drum shaft. The worm gear is totally enclosed, and runs in an oil bath and a thrust block forming part of the worm box casting is provided. The motor shaft is also fitted with an electric brake, the coils of which are in series with the the armature, the brake being put on by a spring when the circuit is broken, and taken off by the magnet when the circuit is closed. The gear illustrated is one which has been delivered to West Australia for hoisting buckets up a mine shaft, and will be bolted to a trolley running on rails so as to serve 4 shafts as required. At each shaft head a reversing controller is fitted which can be coupled to the motor by flexible cables

The capstan, illustrated in Fig. 2, was supplied for hauling coal trucks on a factory siding to replace haulage by horses. It is entirely enclosed in a cast iron box, the top of which is flush with the ground, and will haul about 30 tons along the level at a maximum speed of 200ft. per minute. The motor is of the enclosed Silvertown type and develops about 11 b.h.p. at 820 r.p.m. The cover plate over the motor is removable to give access to the box, which, however, is seldom required, as the worm gear and foot step journal run in an oil bath, and the other bearings are fitted with self-oiling rings.

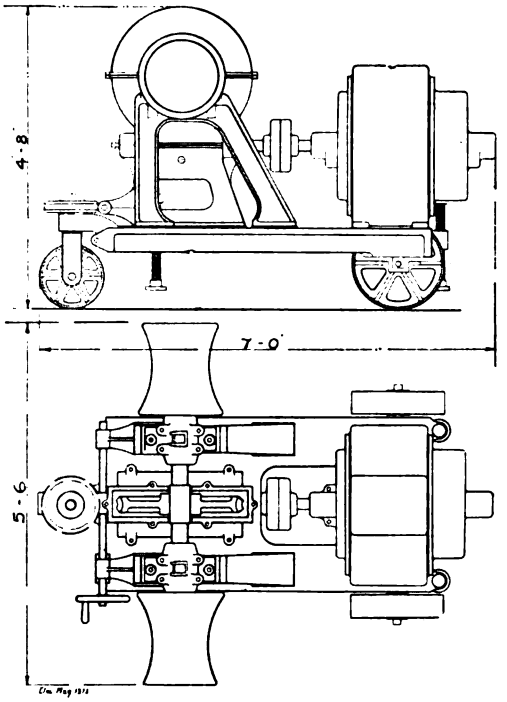


FIG. 3. SILVERTOWN ELECTRIC PORTABLE WINCH.

The portable winch, shewn in Fig. 3, was supplied for unloading barges, and is mounted on a trolley which can be moved about on the quay, and clamped in any required position. The motor is a totally enclosed Silvertown motor of 10 b.h.p., running at 650 r.p.m., driving through a worm gear on to a shaft carrying a warping drum at each end, and is capable of lifting 30 cwt. at 80ft. per minute

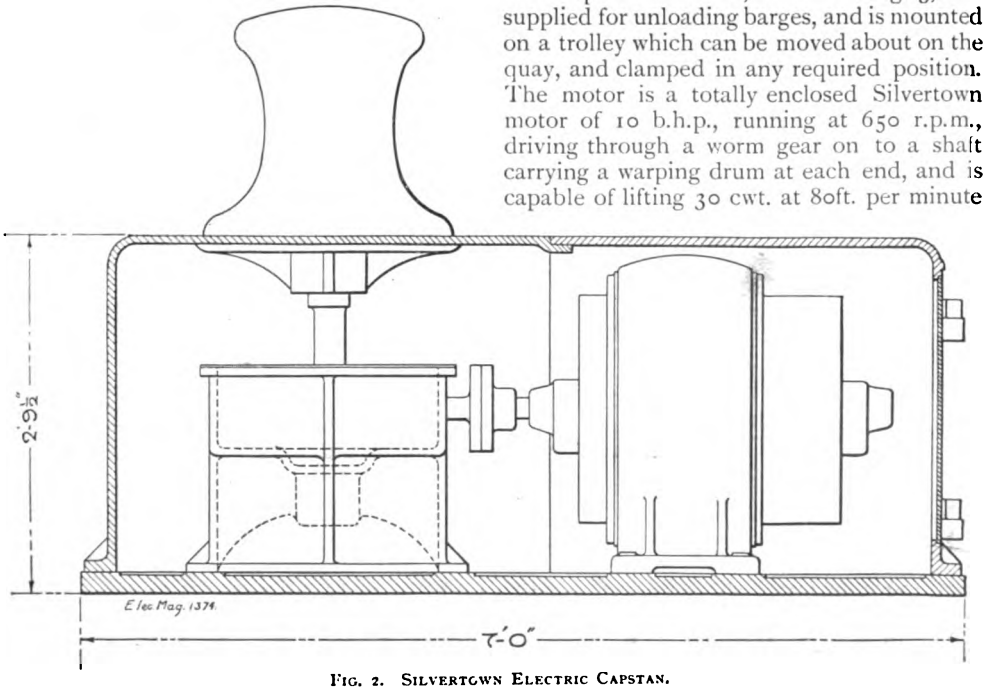


FIG. 2. SILVERTOWN ELECTRIC CAPSTAN.

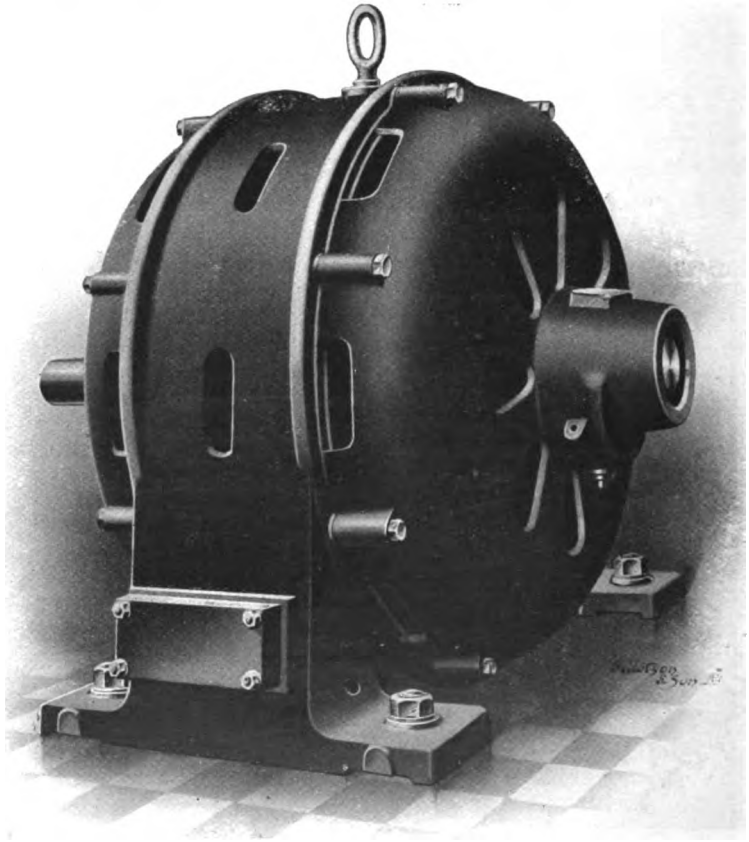
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THE SUNDERLAND FORGE AND ENGINEERING CO., LTD.

Electric Winches.

FOR many years the steamwinch has enjoyed the undisputed possession of a very important field of transport, and its employment has been attended with excellent results. On shipboard especially it has been found indispensable, chiefly by reason of the proximity of steam pipes, and also because its mechanism could be readily understood by the average engineer. The clatter of its engines is a sound familiar to all ocean travellers and frequenters of docks and harbours.

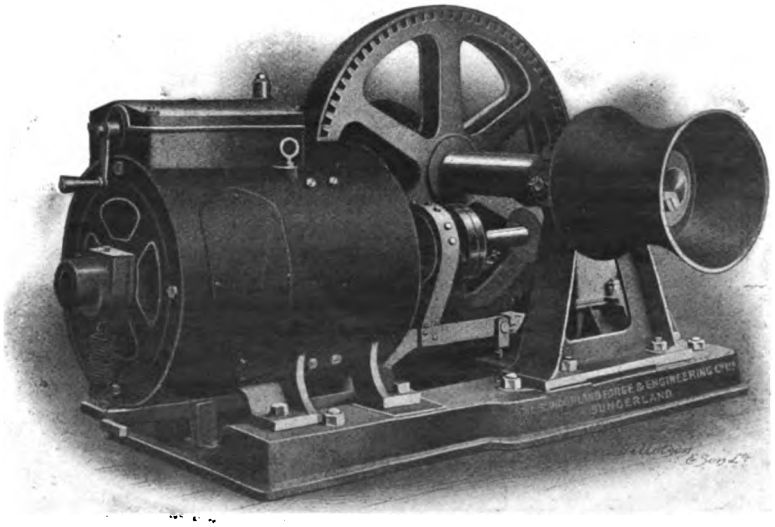
The immunity from serious competition which has characterized its existence. is now to be shared with a rival, and a powerful one at that, in the shape of the electric winch. It has entered into strong competition with steam apparatus, by being adopted on harbour sides and in great docks, on liner and merchantman, and, in fact, at any point which affords a supply of electrical energy.

It is not surprising to find the manufacture of electric winches in the hands of engineers with works adjoining scenes of maritime activity, as there the needed experience is ready to hand, and further can be gained if needed in the application of the devices in question.

During the last ten years the Sunderland Forge and Engineering Co., Ltd., have manufactured a large number of electric winches. The machine illustrated on this page is the perfected outcome of this lengthy experience in the design and manufacture of such machines. It is of very substantial design, the material being distributed in such a manner as to withstand sudden shocks from heavy work, such as are met with in shipyards.

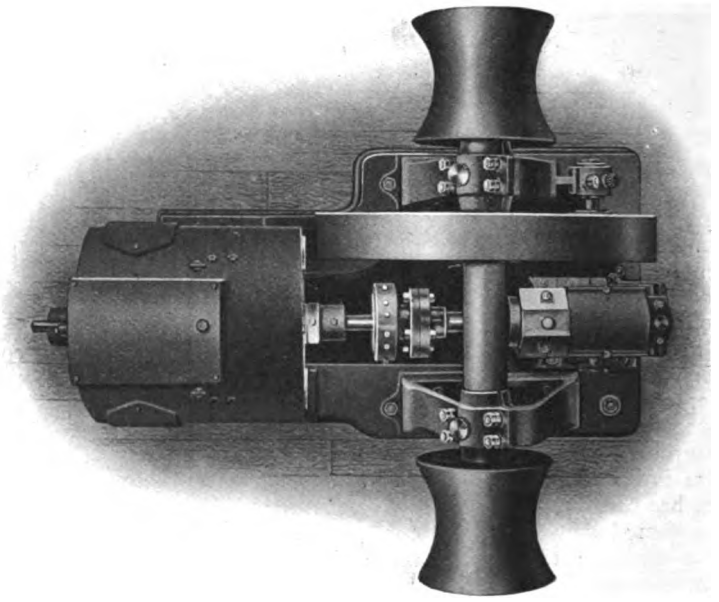
The first reduction gear is through worm gearing—the worm is cut from the solid and gears into a phosphor bronze worm wheel. The worm works in an oil bath, this furnishing perfect lubrication. The end thrust is taken by collars on the worm shaft running in a thrust block lined with white metal, and the second reduction is through machine moulded spur gearing.

The motor is of the firm's well-known "Pallion" enclosed type for continuous current. The firm also manufacture and



SUNDERLAND FORGE 3-TON ELECTRIC WINCH

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PLAN VIEW OF 3-TON ELECTRIC WINCH.

fit alternating-current motors. The brushes are of carbon, and are arranged in fixed positions before leaving the works. The special winch controller is fitted into a watertight box forming part of the motor case, and the resistance is of special construction, being practically indestructible. Both controllers and resistances are of such size that the greatest variation of speed can be obtained, and no undue heating or sparking take place. The whole of the electrical gear is very compact, and it is only necessary to connect the two main cables to the motor when the winch is ready for working. The winches can be worked in exposed positions without fear of damage from the weather. Reference to the illustrations will show that a foot brake working direct on the motor shaft is placed immediately under the motor and the controller handle. This brake is sufficient to maintain the full load of the winch in any position.

The Sunderland Forge and Engineering Co., Ltd., make a number of sizes of these winches, the one illustrated being their three-ton size, designed for lifting this weight at a speed of 30ft. per minute.

It must not be supposed that the electric winch has become the commercial rival of the steam type on grounds of fashion or fad. Like all other forms of power machine, the steam engine, in comparison with the electric motor no matter of what type, has, by hard and long experience, been proved inferior from all points of view. Irrespective of inherent deficiences in the steam engine itself, the difficulties of supplying it with steam are so great, and result in such heavy losses, that where electric p wer is available it should in every case be applied.

The majority of the great shipping centres, and all large and important ocean-going vessels, are all provided with power plants, and this solves at once the initial problem of furnishing the requisite energy. It only remains to see the electric winch, or capstan, or hoist, as the case may be, in actual operation, and to have figures of its performance reiterated, to be convinced of its value as an efficient and reliable device.

The electro-motor is no laboratory plaything to be attended by skilled men, or to require constant adjustment. Years of experiment have borne good fruit in its development, and to-day it stands pre-eminent among the known power agents. Small wonder then that such industrial appliances as the winch are now fitted with the ever ready electro-motor.

The Sunderland Forge and Engineering Co.'s experience in this province is unique, and is, of course, placed completely at the disposal of its clients.

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ELECTRIC HOISTING AND CONVEYING MACHINERY.

THE electric hoist is now a common feature of the daily life of great cities and towns. Its merits have been recognised because they could not fail to meet with public approbation, and it is merely a matter of time for the hoisting, lifting, elevating, and conveying devices driven by steam and other means, now to be operated by the more efficient and reliable electromotor. Messrs. J. G. Child and Co., of Willesden Green, have made a particular study of this class of apparatus, and below we give some details of their designs.

Fig. 1 shows one of their electric service lift gears operated on the push-button principle. The particular gear shown has a capacity of 3cwt., but where lighter loads are required to be handled, a smaller gear can be supplied. The electric push-button lifts (for passengers, goods, and service) built by J. G. Childs and Co., Ltd., are the outcome of a large and wide experience, and the firm claim that their lift is practically fool-proof—a claim which they are prepared to demonstrate. These lifts are built for a capacity of from 10lbs. to five tons, and can be operated at any desired speed, as the system of control obviates the necessity of an attendant. This should commend itself to those who require the most efficient and up-to-date method of operating lifts. The lift gear consists of a strong cast iron bed plate, on which is mounted the motor worm gear and winding drum or sheave. The worm wheels are made with a phosphor-bronze rim mounted on a massive cast-iron centre. All gears are fitted with powerful electric brakes, which immediately come into action directly current is cut off. The high efficiency of the above firm's lifts is evident from the fact that 400 tons per week can be raised a height of 20ft. at the very low cost of 2s. 11d. with current at 2½d. per unit.

While giving special attention to the direct current electric lift, Messrs. J. G. Childs and Company, Ltd., have not overlooked the importance of the single phase lift for commercial purposes, and are able to cater for this class of lift for both passengers and goods. The motor is direct geared by means of a rigid coupling so that the gear is only in motion when the lift is in use. These lifts are thoroughly reliable and are fitted with a special electric brake which is applied directly current is cut off.

The great feature of this gear is that it is capable of starting up under full load, giving full load torque at practically full load current. It will start, stop, and reverse, and proves itself as reliable as any direct current lift gear. The firm also make a speciality of polyphase lifts.

Messrs. J. G. Childs and Co., Ltd., have paid particular attention to the manufacture of a special type of automatic electric hoist, of which they are the patentees. A large number of these have been fitted at the Docks Cold Stores and Warehouses in this country and abroad. One particular form, shown on the advertisement page following, is capable of dealing with 500 bundles of papers each weighing 80lbs. These can be raised a height of 18 to 20 feet at a cost of one penny with current at 2½d. per unit.

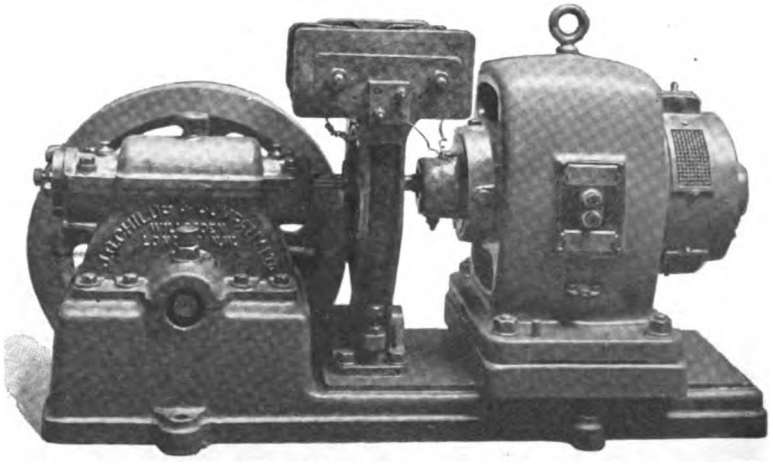


FIG. 1. J. G. CHILDS' ELECTRIC SERVICE LIFT.

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THE HARMAN ELECTRIC HOIST.

It is high time for architects and builders to realise that electric power mains more frequently than not adjoin the scene of their daily operations. The trouble they take in carefully carting a huge boiler, with its hoisting engine, from place to place gives the layman the impression that no other power agent is available for the purpose. The man in the street may be excused if he departs with this impression, but neither builder nor architect can be let off thus lightly. The electric hoist has been a *fait accompli* for several years now, but through no fault of its own have its merits been overlooked. Again, it cannot be argued that the electric hoist is a rarity in the market and difficult to obtain. If there are still any interested parties in doubt as to the reality of the electric hoist, the following particulars of a modern example of that ilk may serve to enlighten their ignorance. The hoist illustrated on the succeeding page has been designed for use among builders and contractors, and since its introduction has given absolute satisfaction. It is extremely simple and portable, the whole gear being mounted on one bed-plate.

The gearing is of the worm-type, and enclosed in a dust-proof case, it is machine cut, and ball thrust bearings are fitted at each end of the worm shaft, thus reducing the friction due to end thrust to a minimum. The gear case is kept partly filled with oil, which is taken up by the worm wheel, thus ensuring perfect lubrication of the worm, worm wheel, and bearings.

A series-wound semi-enclosed electric motor is used for hoisting purposes; the shaft of the motor and that of the worm are coupled together for direct driving. One half of this coupling is enlarged to form a drum, on which acts a very powerful electro-magnetic brake.

A solenoid coil wound in series with the field-magnets of the motor is securely fixed on the bed-plate, the function of this coil being to release the brake whenever current is applied to the motor. The mechanism of the brake renders it impossible for the attendant to make any mistake, it being entirely out of his control. The brake being applied automatically by an adjustable weight on a lever whenever current is cut off from the motor, and can only be released by applying current to the motor.

The whole working of the hoist, including starting, reversing and stopping, applying and releasing the brake, is done by one handle on the controller. Messrs. Harman & Co. use a liquid controller in connection with their hoists, and this is giving every satisfaction. It consists of a cast-iron frame and tank, and is of very strong and serviceable construction. The movement of one handle only starts, stops, and reverses the motor.

These hoists are at present being made in two sizes: No. 1 to lift 8 cwt. at a speed of 80ft. per minute, and No. 2 to lift 1 ton at 100ft per minute.

Messrs. Harman are, however, prepared to construct hoists of any capacity up to 5 tons.

For passenger lifts the same gearing is employed, substituting a grooved driving wheel in place of the drum, and an automatic controller in place of the liquid one.

This controller is of a novel type, the ordinary resistance coils being dispensed with, and in their place a special type of resistance plates are used, which give a much larger area of cooling surface than is possible with spiral coils.

The action of the controller is absolutely reliable, and can be operated either with a hand rope in the ordinary manner or with Messrs. Harman & Co.'s new type of cage switch, and also on the push-button system. A new type of this manner for controlling passenger and service lifts is now being manufactured by Messrs. Harman & Co., and which we hope to illustrate fully at an early date.

It may be well to clench the argument here put forward by stating that there is not the least difficulty in obtaining the electricity to operate machines of this description. Every large town has now a power supply, and, if mains are within reasonable reach, they can always be temporarily "tapped" by arrangement with the chief engineer. There is no need to be lumbered in building operations, for instance, with clumsy and awkward, not to say inefficient, steam plant, when with the electrically driven device twice as much work can be obtained.

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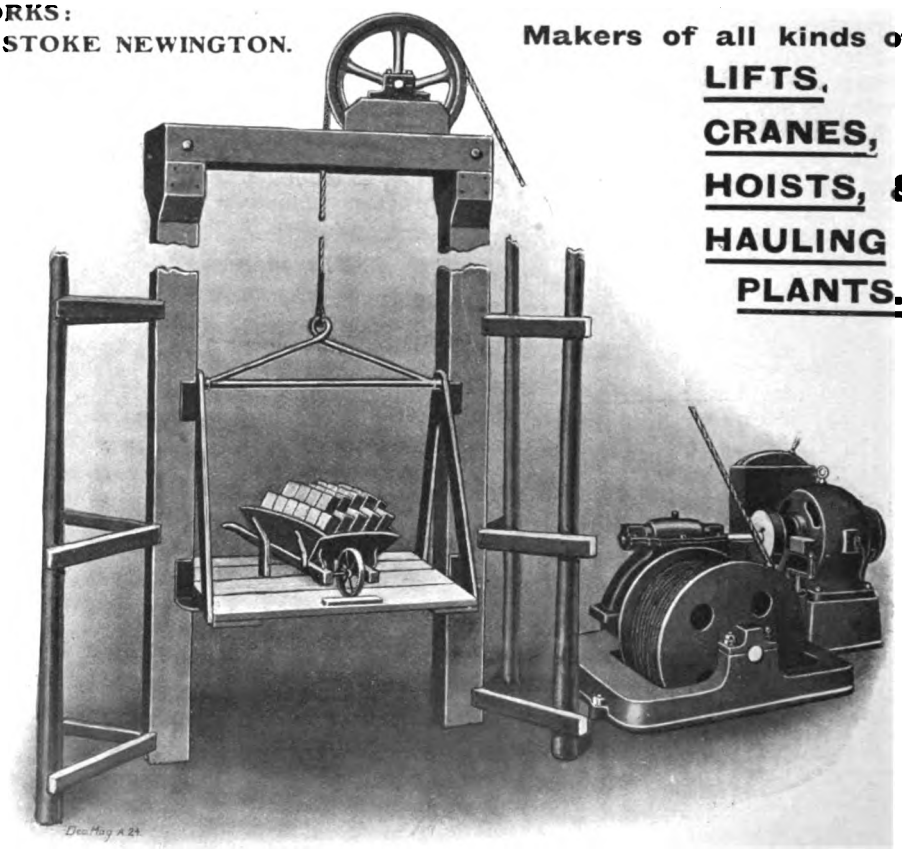
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ELECTRO-MAGNETIC BRAKE GEARS FOR CRANE MOTORS.

Laurence, Scott & Co., Ltd.

On account of the loss of power involved in series wound brakes, solenoid shunt wound brakes have been extensively used. They have, however, the following serious disadvantages :—

They involve separate contacts in the controller and extra wiring outside.

They absorb electric power, especially when a non-inductive resistance is used, as it generally should be to prevent damage to the insulation of the brake coil.

The most serious objection to them is the risk of accident or failure. As there are two distinct circuits, it may happen that one of them is interrupted. The shunt solenoid circuit is the most likely to break down, and if this occurs the brake will not be lifted when the current is switched on, so that the fuse or circuit breaker will "go," causing delay until the damage is put right. If, however, the main motor circuit should be interrupted whilst the solenoid circuit is intact, the result may be very serious indeed, as the load might run down unchecked before the attendant could discover why the motor did not respond to his usual working of the controller handle. This would constitute a possible danger to life.

With Laurence, Scott and Co.'s "flapper' brake gear these dangers are entirely avoided as the brake must be "on" when the current is "off," and "off" when the current is "on," except that the brake goes partly on when running on very light load, and so prevents excessive speed.

Messrs. Laurence, Scott and Co. have succeeded in utilising the magnetism developed in the motor itself for actuating the brake gear without interfering with the mechanical simplicity and strength of the Motor itself. A gap or a partial gap is left in the magnetic circuit at the root of two of the pole pieces, so that most of the lines of force pass across the gap and through the

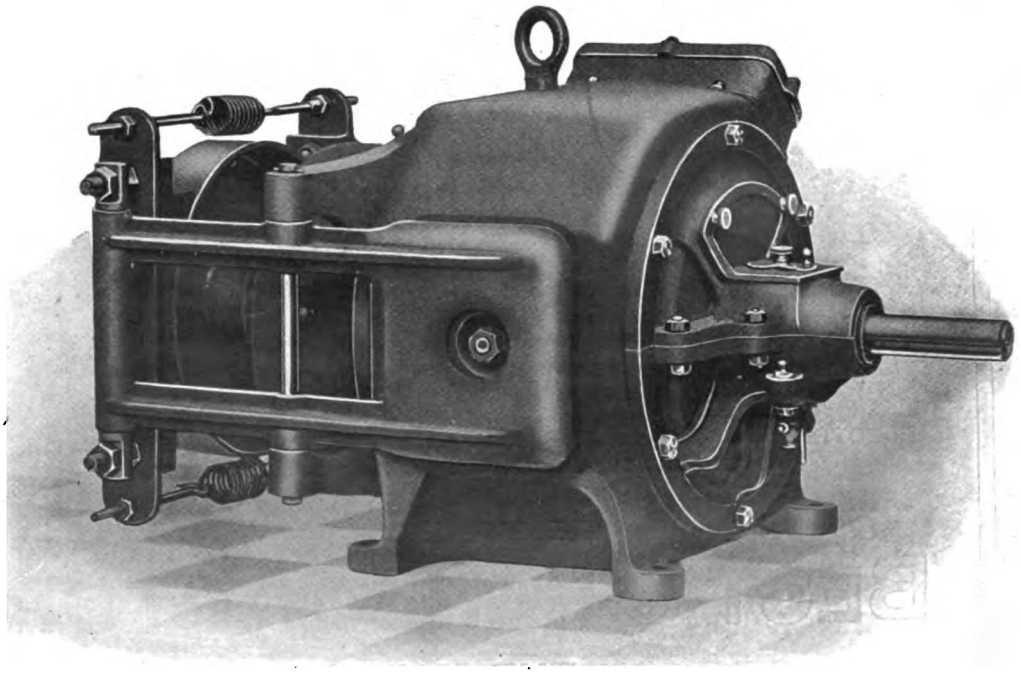


FIG. 1. CRANE MOTOR FITTED WITH MAGNETIC "FLAPPER" BRAKE.

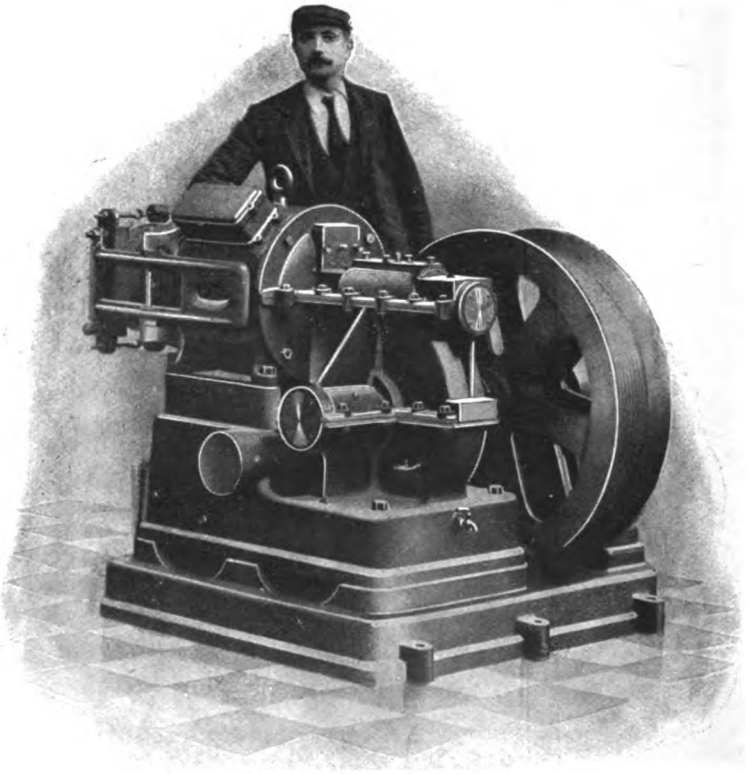
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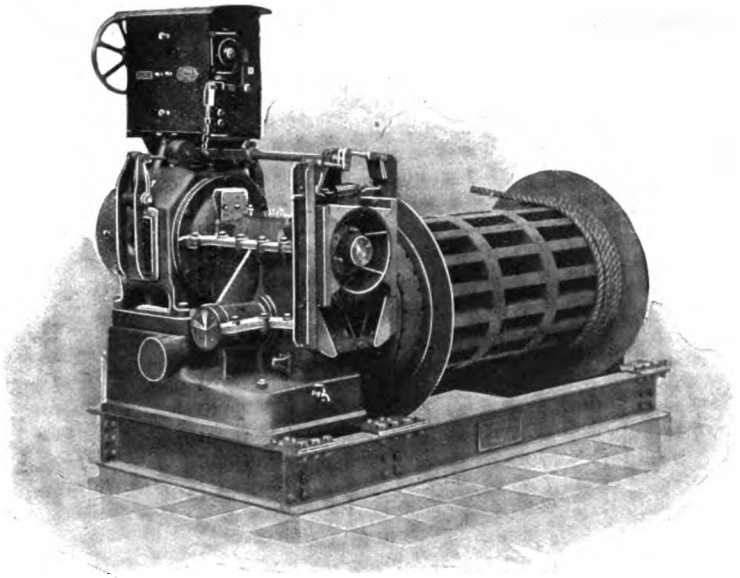


FIG. 2. MINING WINCH WITH INTERLOCKED CONTROLLER.

brake "flappers," which are thus attracted. The brake-gear is simplicity itself, and it is all made of cast or wrought steel, while the wooden brake-shoes are easily adjustable for wear. They are usually arranged to be put on by means of two springs, which are in parallel, so that an accident to one of them would not release the brake.

Fig. 1 shows crane motors fitted with these "flapper" brakes, the brake being at the commutator end. This is found by experience to be the best place for the brake in the majority of cases, as it enables the pinion at the other end to be fixed close up to its bearing.

Fig. 2 illustrates a mining winch with controller over the motor, and a rather different style of "flapper" brake. In this arrangement it will be seen that the "flappers" are made to operate a way shaft, which puts on the brake by means of a toggle. This brake, however, can be lifted off mechanically for lowering.

It may be said that for the great majority of lifting operations by means of reversing motors an electrically-operated brake is an absolute necessity, *i.e.*, one that puts the brake on directly the current is broken. Without such a brake, the load, if the gearing is at all efficient, begins to run down as soon as the current is taken off, and in some cases no arrangement of interlocked mechanical brake gear is sufficient to prevent running back. At the same time, it is very convenient to be able to take off the brake mechanically for lowering, and with a mechanically-operated brake the control over the lowering is much more complete and certain than can be obtained with any electrical gear which is simple and cheap enough for ordinary use. In the winch shown the magnetic brake is retained, and in lifting the load is held directly the current is broken. If, however, the controller handle is turned in the lowering direction, the brake gear is lifted by means of a cam, bell-crank, and lever as shown, so that very complete control is obtained over the lowering, and this lowering is done without any electrical power being used, or rather wasted, as it is in some methods in common use. The controller is so arranged that after the brake has been lifted off current can be applied to the motor, which will run it in the lowering direction. This is useful for starting down weights which are not heavy enough to start the gear in motion. The cam action takes the brake off or puts it on very gradually, so that complete control is obtained.

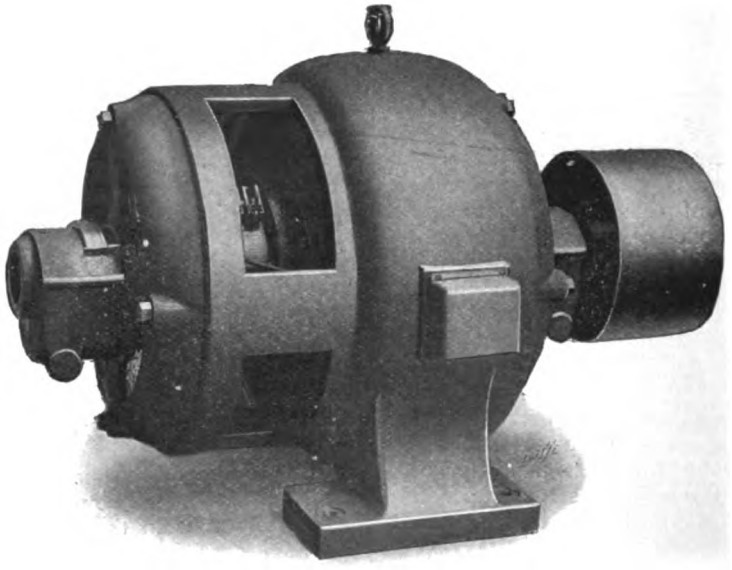
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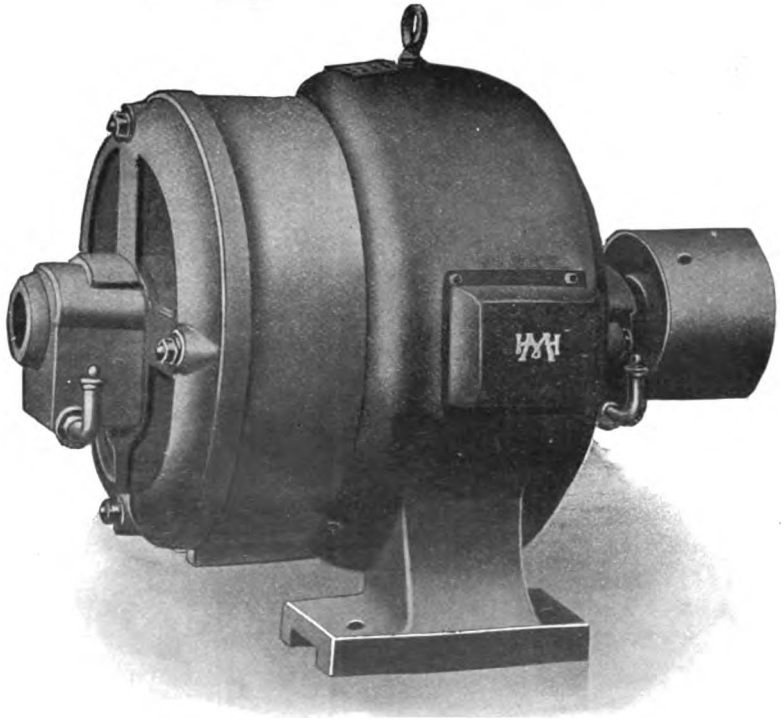
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MORRIS-HAWKINS CRANE MOTORS.

THE motor products of the Morris-Hawkins Electrical Co. include a special line adapted for the exigencies of crane and lift work, the normal rating for continuous working being largely increased. A standard frame, similar to that shown on this page is used, and the windings are so designed that the heavy but spasmodic demands on the motor are met without overheating, and they can also stand up to considerable overloads and keep cool. A special feature is made of the commutator. Although the motors are highly rated, sparking at the brushes is entirely absent, and, further, the brushes themselves are in a fixed position. The brush holders are very strongly made and fitted with carbon blocks of ample section and contact area, thus ensuring cool running at all loads. Extra strong shafts are fitted to this type of motor, and great care has been bestowed on the lubrication.

The motors made for cranes, lifts, and hoists are of the series and compound types, and are built in sizes up to 100 b.h.p. All parts are made strictly to gauge and are readily interchangeable. An important feature in the construction is the extreme lightness obtained in the finished motor. This is a valuable matter when the motor has to be carried on a crane, for example, or fitted to a portable hoist. At the same time the mechanical soundness of the motor is maintained throughout, and the power exerted is in no way diminished.

It is important, in the fitting of electromotors to cranes, hoists, and any type of transporting device, that the products of standard makers of repute be selected. Further, the question of delivery is an item which must not be overlooked, and makers whose works are fitted with modern machine tools are less handicapped in serving clients wiih a minimum of delay, than manufacturers with older and slower tools. The Morris-Hawkins Electrical Co.'s Works, at Dagenham, Kent, are equipped with the best types of modern tools, and this circumstance not only ensures the prompt execution of orders, but the production of high-class and efficient motors at all times.

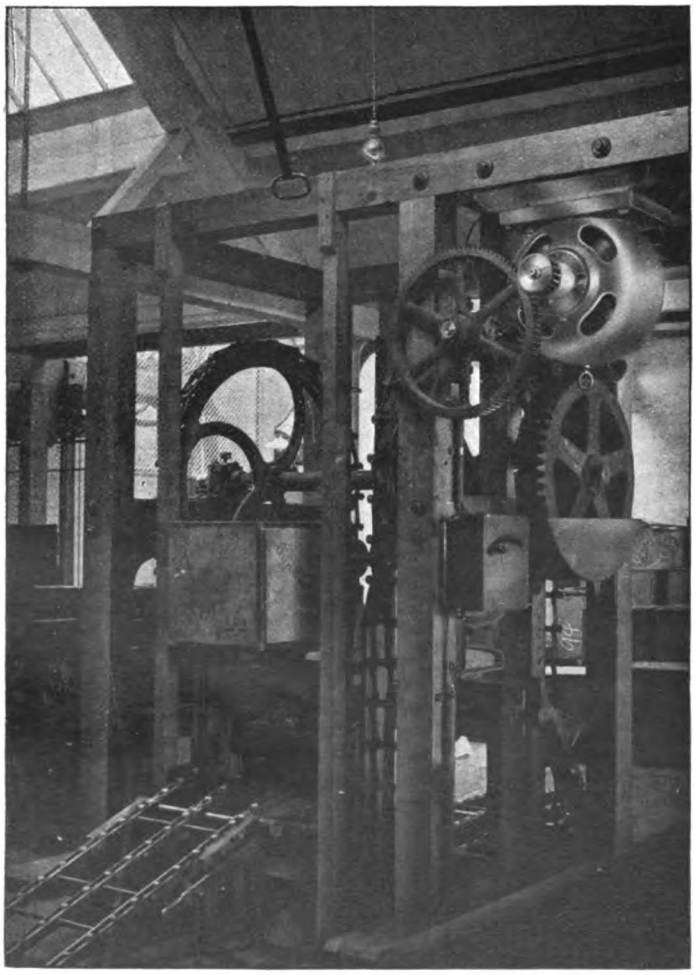


MORRIS-HAWKINS STANDARD "TOTALLY ENCLOSED" MOTOR.

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ELECTROMOTORS, LTD., AND THEIR CRANE MOTORS.

ELECTRICAL systems are now recognised as the standard of up-to-date practice for all questions of transport or haulage, and the most important consideration is the selection of the type of apparatus to suit the particular requirements of the user. Having fixed upon the type of haulage gear, or crane, or whatever it may be, probably the next question which presents itself, and certainly the next in importance, is the selection of a suitable motor for the purpose, which, subject as it is to all the shocks and strains that accident implies or emergency compels, must be liberally proportioned in those parts which come between the "Anvil and the Hammer." Such a motor is shown in the accompanying illustration—familiar to all users of electric power—and is manufactured by the well-known firm, Messrs. Electromotors, Limited, of Openshaw. The parts which come between the "Anvil and the Hammer" in a motor are the windings, shaft, and rotating parts. It is very evident that it is useless to take a standard motor, to push up the outputs to what is called crane rating, and yet leave, say, the shaft the same diameter as before unless it has been previously designed very heavy. A chain is as strong as its weakest link.



MOTOR OPERATING A HOIST. (ELECTROMOTORS, LTD.)

In the same way the windings or any of the other essential parts can be considered. For instance, a winding may be good enough—in fact, excellent—for a motor which has a steady load in one direction, but when that motor has to reverse, and has in addition the racking and jarring due to driving say a crane, that excellence is very much discounted. So we could go on, but the nett results are, as stated above, always the same, viz., that a motor for this class of work must be specially designed for it.

As regards reliability when the design is right, there only remains the execution to consider, and, as engineers are aware, the only solution to the question of production of consistently reliable machinery is specialisation. The very varied and extensive experience which Messrs. Electromotors, Ltd., have had in the construction of motors for all classes of electrically-driven hoists, cranes, elevators, conveyors, &c., have placed their manufactures in the very fore-front of not only this country's but the whole imperial market for this class of work-

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A NEW SWITCH CONTROLLER FOR ELECTRIC LIFTS.

FOR operating electrical lifts the usual system of manipulating the motor controller by means of a rope passing through the car does not give that perfect control which is desirable, while the objections to it increase with the speed at which the lift is designed to travel owing to the increased difficulty of grasping the rope and giving the necessary movement to the motor controller.

To obviate this various designs have been made with a view to the adoption of a controlling system which can be entirely worked from the car by means of a so-called "car" switch, the connection between car and motor controller being made by a flexible multiple cable. There are, however, difficulties in the way of constructing a satisfactory controller of this pattern which are claimed to have been satisfactorily overcome in the new apparatus which forms the subject of the following description.

It will be seen from Fig. 1 that the whole of the gear which forms the motor controller is mounted on one slate panel, which is supplied ready for fixing to either wall or ground.

At the top on the left hand a D.P. "main" switch with magnetic blow-out on both poles is fixed. On the right of this there is a six point switch operated by a solenoid with an adjustable governor to limit the speed of travel of the contact brush. Below these are two D.P. "direction" switches interlocked so that only one switch can be closed at one time. There are also five S.P. switches of which that in the centre controls a rheostatic brake, the others operate a rheostat which is fitted at the back of the panel and placed in circuit with the armature of the motor. At the lower left hand corner there is a S.P. switch which operates the solenoid band brake, whilst on the right there is a field rheostat operated by a solenoid, which is inserted in the field of the motor for giving speed acceleration.

The rheostatic brake above referred to is provided in addition to the usual magnetic, and consists of a resistance which can be placed across the armature terminals, which tends to reduce the speed of the motor instantaneously. The whole of these switches are electrically operated by means of the switch already mentioned as being placed in the car and which is shown in Fig. 2. It has two or more contacts on either side of the centre, the number of contacts corresponding with the different speeds desired. Its first movement closes the main switch, one of the direction switches, and the switches controlling the rheostat and band brakes. The brakes are thus removed and current is applied to the field and armature of the motor,

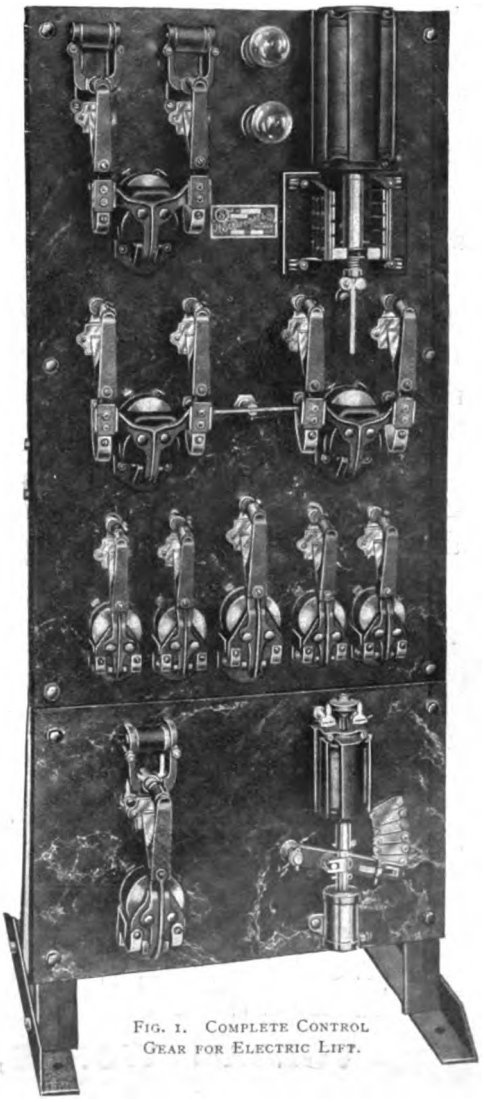


FIG. 1. COMPLETE CONTROL GEAR FOR ELECTRIC LIFT.

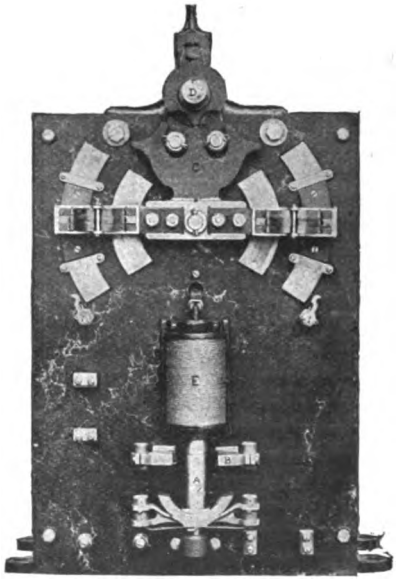
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FIG. 2. CAR SWITCH.

so that the lift starts moving with all resistance in the armature circuit. The main switch on closing excites the solenoid operated six point switch, which responds by exciting in succession the four switches of the armature rheostat, thus gradually cutting out all resistance and causing the motor to accelerate to normal speed. A further movement of the car switch then cuts in the solenoid operated field rheostat, which gradually inserts resistance into the field circuit and accelerates the motor up to top speed. The car switch is provided with a centring spring so that in the event of the attendant removing his hand from the switch the car stops. Additional speeds are obtained by further solenoid switches with corresponding steps in the car switch.

In stopping the lift, the resistance is first cut out of the field circuit, then the main and direction switches are opened and the armature resistance put into circuit while the brakes set. Reversing is effected by moving the car switch in the opposite sense, thus operating the corresponding direction switch.

The magnet and solenoid switches are of a new design arranged to give an efficient contact with the minimum expenditure of power for operation, while each breaking point is fitted with carbon contacts and, where necessary, a magnetic blow-out. Every current-carrying part is renewable, and to reduce the consumption of energy to a minimum, magnets and solenoids are so arranged that a high resistance is thrown into circuit after their respective switches have closed.



FIG. 3. LIMIT SWITCH.

To prevent overrunning of the lift at the extreme limits of travel a special limit switch, Fig. 3, is provided, which is operated from the automatic shaft of the lift gear, and is so set that the lift is automatically stopped at the top or bottom landing stage without intervention of the lift attendant. The connections of this switch prevent the lift being deliberately taken beyond the set limits, but allow reverse movement as required.

In this controller every provision is made of prevent the possibility of mishap whilst providing every facilty for inspection and replacements, the whole construction being on switchboard lines, with every connection in full sight.

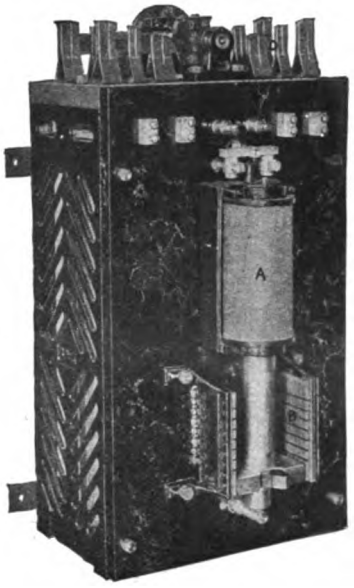


FIG. 4. SOLENOID CONTROLLED RHEOSTAT.

The apparatus is being put on the market by Messrs. Geipel and Lange, who inform us that it is already meeting with a most favourable reception, presenting as it does a great advance upon other types designed for similar purposes. In addition to the pattern above described, we understand they are now able to supply a complete range of electric lift controllers comprising some fifteen different patterns suitable for service goods and passenger lifts for a variety of purposes. A wall-pattern motor-starter with solenoid rheostat is shewn in Fig. 4.

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CONTROLLERS FOR LIFTS AND CRANES.

The Sturtevant Engineering Co.'s Specialities.

THE provision of adequate controlling devices for cranes, lifts, hoists, and transporters needs as much care and forethought in design as do the heavier parts of the machines in question. Each is rendered useless or, what is worse, highly dangerous if the controller gear is badly planned and flimsily made. It is not enough to put an ordinary controller built for light work, nor even to take some such device from stock and couple it up regardless of the working conditions of the motor it governs. For these reasons rheostat and controller specialists are essential to the equipment of electrical transporting devices and only lengthy experience is a guarantee of good work in this field.

The Sturtevant Engineering Co. have for many years made a special study of controlling appliances, consequently they can not only advise as to the most suitable types but can also make and supply them with equal confidence. For lift work a special line is made of reversible controllers, particulars of which are here given.

The Controller consists of four pieces of apparatus, namely :—

A Sturtevant Solenoid Controlled Rheostat, as illustrated by Fig. 2.

A Sturtevant Reversible Car Switch, as illustrated by Fig. 1.

A Sturtevant Limit Switch.

A Sturtevant Brake Solenoid.

The whole apparatus is operated by means of the car switch, which opens all circuits when the handle is in the central position and causes the lift to travel in one direction when the handle is moved to the right, and in the opposite direction when it is moved to the left. This car-switch does not handle the main current of the motor, but only shunt currents which are used for exciting solenoid switches, which shunt currents never exceed about half an ampere. Consequently, the car-switch is a very durable piece of apparatus, as the liability to sparking on its contacts is reduced to a minimum.



FIG. 1. REVERSIBLE CAR SWITCH.

The movement of the car switch from the centre first excites two of the four solenoids, which are to be observed on the right hand side of the solenoid controlled rheostat, causing them to close their switches and so determine the direction of rotation of the motor. The solenoid controlled main switch at the bottom left-hand corner of the rheostat then closes and supplies current to the motor through all the rheostat resistance, while at the same time the brake solenoid is excited, causing it to release the brake. The accelerating solenoid, which is mounted at the upper left-hand corner of the rheostat, is then excited, and pulls up the contact lever at the speed to which the dashpot has been previously adjusted, thereby slowly cutting out the resistance, and bringing the motor gradually and easily up to normal speed.

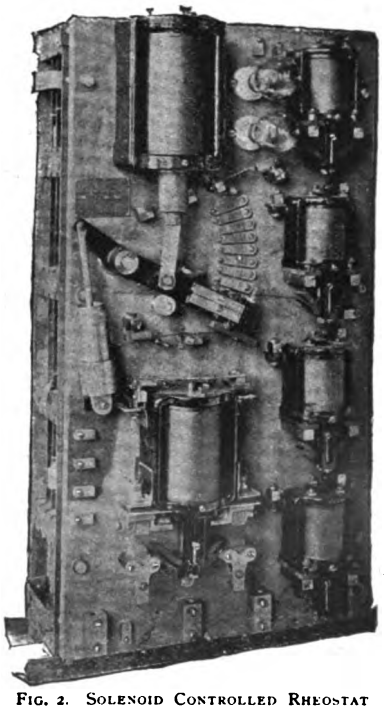


FIG. 2. SOLENOID CONTROLLED RHEOSTAT

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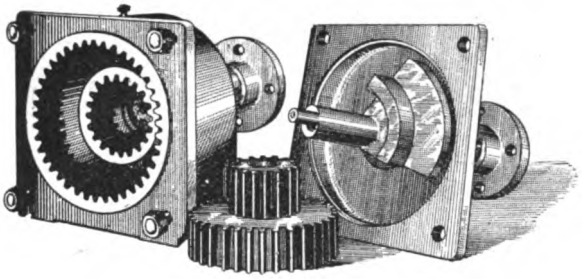
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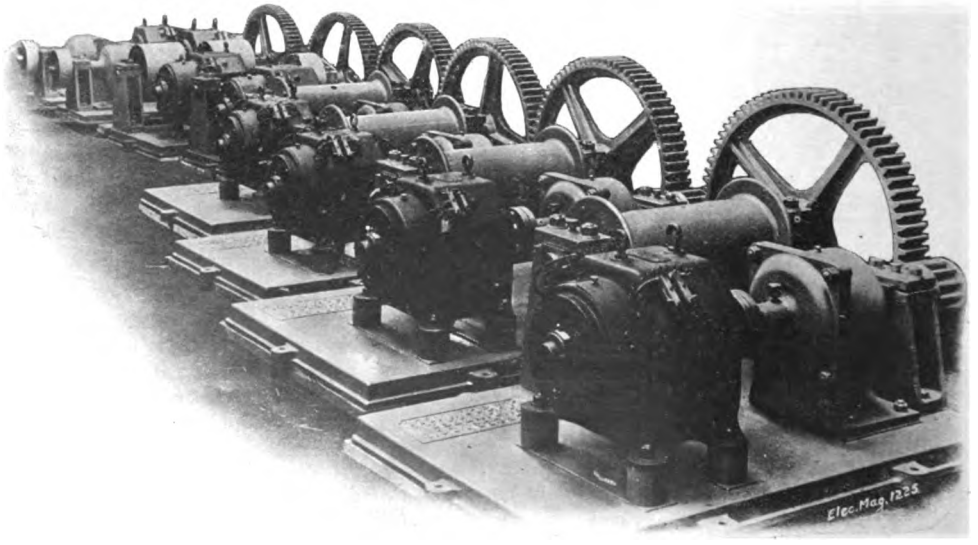
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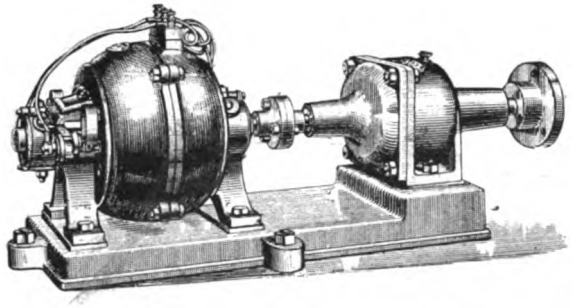
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SPEED REDUCING GEARS FOR ELECTRIC CRANES, HOISTS, ETC.

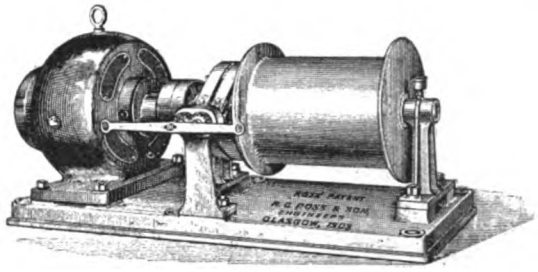
R. G. Ross & Son's Specialities.

THE high speed at which the electro-motor normally runs necessitates the employment of speed reducing devices when such machines as lift gears, hauling plants, hoists, &c., are to be driven. It is now common practice to use several pinions and spur wheels, or worm drives, in effecting this reduction, with the result that the complete machine occupies much more space than it actually would if the speed could be lowered by some other method. The direct current motor is of course readily adaptable for very wide variations of speed, but the necessary modifications introduce elements almost as complex as the additional gearing. What is of course required is some middle course in which a standard motor can be utilized and, at the same time, the gearing for the speed reduction is not too cumbersome, but will be equally efficient.

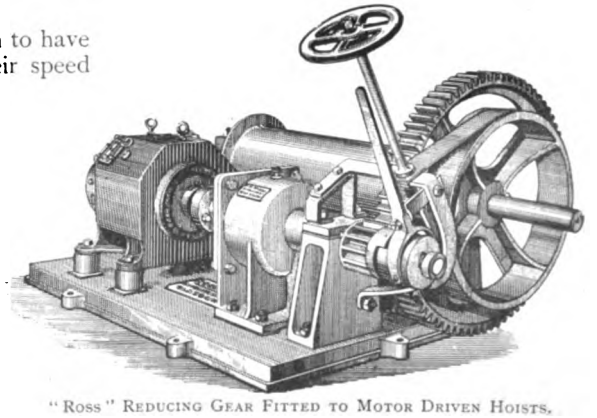


MOTOR FITTED WITH "ROSS" REDUCING GEAR FOR HIGH-SPEED MOTORS.

Messrs. R. G. Ross and Son seem to have hit upon this happy medium in their speed reducing gears for cranes, hoists, winches, &c. The adjoining illustrations depict the practical application of this gear to motors for the class of machinery mentioned. A feature of the gear is the alignment of both the high and low speed shafts, the motor spindle being in the same longitudinal plane as the shaft fitted with the reducer pinion. The gears are enclosed in a substantial casing bushed at the centre for the two shafts, and fitted with a supporting foot. The encasing of the gear wheel removes an obvious source of danger in hoist and lift gears, haulage plants, &c., all of which are generally fitted with exposed gears liable at any time to catch the clothing of attendants, or any loose material in the neighbourhood. Any desired reduction can be effected, and to give some idea of the range it may be stated that in one case a motor running at 460 r.p.m. was coupled to a Tukes furnace revolving at the extremely low speed of 4½ revolutions *per hour*. The gears are quite positive in action, and amply lubricated as they run in oil. Further, the driving-wheel teeth being internal and external a greater number of teeth are always in mesh and undue shock or strain of surrounding parts is avoided.

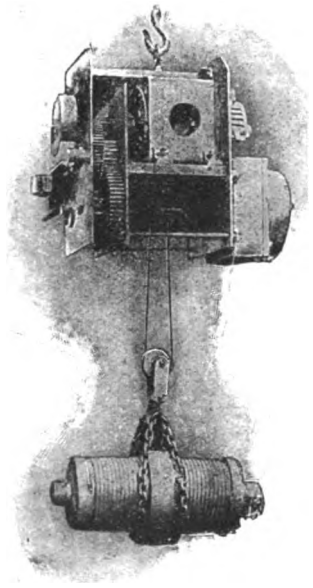


SIMPLE FORM OF ELECTRIC HOIST REGULATED WITH ONE LEVER.

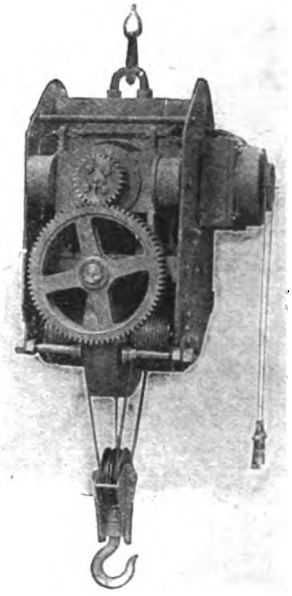


"ROSS" REDUCING GEAR FITTED TO MOTOR DRIVEN HOISTS.

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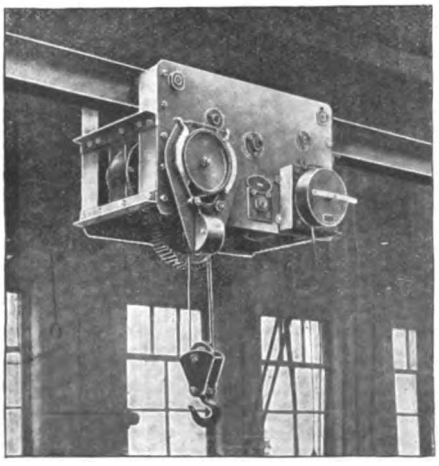


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Telegrams: HEYWOOD, Electrician, REDDISH.

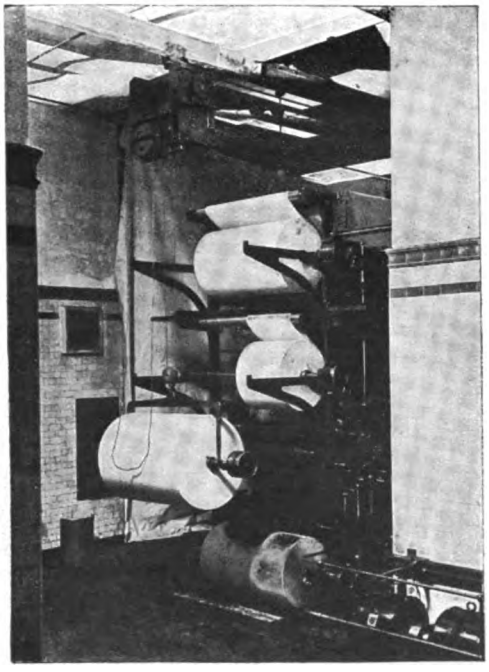
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ELECTRIC PULLEY BLOCKS.

S. H. Heywood, Reddish.

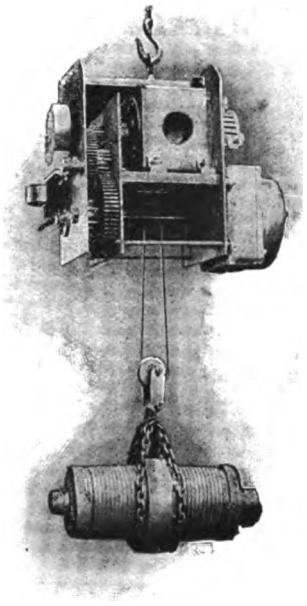
ONE of the most interesting examples of electrical transport devices is the motor driven pulley block. In these days of labour-saving machinery nothing looks more incongruous, not to say ridiculous, than three or four men expending their energies, which are very inefficiently applied, in hauling at the chain of pulley tackle. The neat, compact, powerful and efficient electromotor dispenses entirely with all this misapplied effort. To mention the multifarious uses to which pulley tackle is put would fill all our available space, but there can be no doubt that this handy little device when electrically driven becomes practically indispensible.

This branch of electrical engineering naturally requires special treatment, and Mr. S. H. Heywood, of Reddish, near Stockport, has made an exclusive study of the devices referred to. One or two examples of his pulley blocks and running hoists are given herewith. The electric pulley blocks effect a remarkable saving in labour, and can be used wherever a power supply is available.



10-CWT. ELECTRIC PULLEY BLOCKS HOISTING REELS OF PAPER INTO TWO PRINTING MACHINES.

It is possible for one man to do more work with an electric pulley block than three men



ELECTRIC PULLEY BLOCK ATTACHED TO ORDINARY CRANE HOOK.

can perform with the hand operated device. The blocks can be attached to jib cranes suspended from derricks or arranged to run on the flange of a steel girder, travelling being done by electric power or by hand. They are made in sizes from 10 cwts. to 4 tons, and for any desired speed of lift or travel. The bearing parts are all of substantial construction giving a minimum of wear and friction. An efficient electric brake is fitted on the motor spindle, this coming into action directly current is cut off. In every case the brake can sustain the maximum load. The controller is operated from the ground level and can be fitted with a spring for returning the contact arm to the off position should the rope be released. A great number of these blocks and travelling hoists are in use giving entire satisfaction. Mr. S. H. Heywood also converts existing rope-driven travelling cranes to electromotor control, and has already carried out a number of such alterations with complete success.

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Shunt Motors for Crane Work.

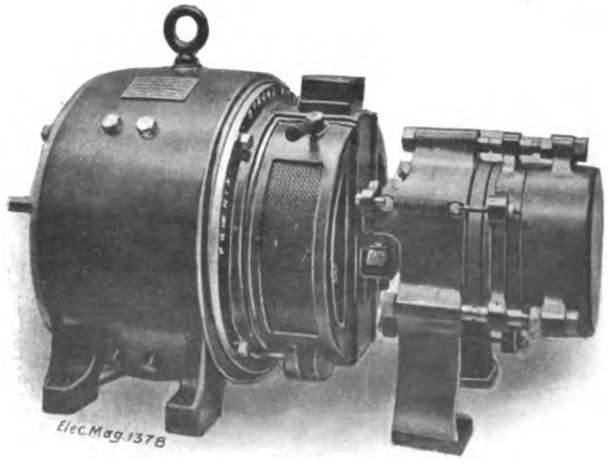
THE great advantage of the series wound motor in the past has been its large starting torque at low speeds, and also the fact that, while at full load it ran at its normal speed, at no load it ran at a considerably higher speed, and so automatically carried lighter loads at greater lifting speeds. The Phœnix Dynamo Manufacturing Co., Bradford, are now perfecting a line of motors, shunt wound, fitted with patent auxiliary poles which give a very large speed variation, in special cases up to 5 to 1 ratio, simply by shunt resistance. These particular machines, which are remarkable for the absence of sparking, even at very high overloads, permit of the load being thrown suddenly "off" and "on," and there is no doubt that a considerable class of crane work will be served in the future by such shunt wound motors rather than by series wound motors, thus getting over a great deal of the difficulties which at present exist in starting and regulating switches, which vary the speed by inserting resistance in the main or armature circuit.

The attached illustration shows one of the Phœnix Dynamo Manufacturing Co.'s motors fitted with a magnetic brake, of which they have supplied a considerable number for crane purposes, and also for rolling mills, &c. The brake is arranged so that it is held on by a spring, bu t directly the current is switched on to the motor the solenoid or magnet pulls against the spring and relieves the brake pressure, so that in the event of failure or cessation of current the brake will pull up the load as directly the current is switched off the motor is stopped by the brake immediately.

The Phœnix Dynamo Manufacturing Company have supplied to numerous crane makers round the country crane motors, both continuous current and polyphase. In the continuous current motors, they are in nearly all cases series wound, and are designed so that at the end of one hour's run at full load they shall not have a greater temperature rise than 75° Fahr. above the temperature of the surrounding atmosphere.

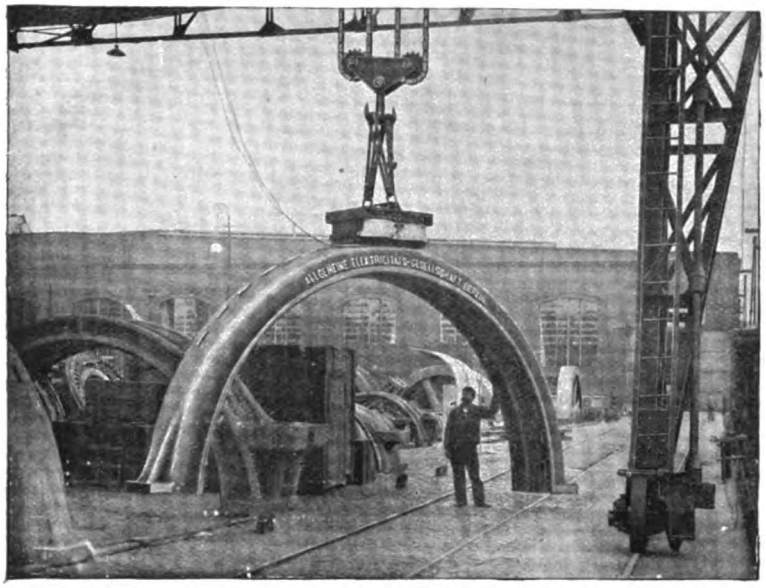
Motor for Cranes, Hoists, &c.

Among the prominent makers of motors for cranes, conveyors, hoists, and other transporting devices, the Lancashire Dynamo and Motor Co., Ltd., occupy a prominent position. Their works at Trafford Park are equipped with modern machine tools, and operated on organised lines; consequently they are able to guarantee quick deliveries of their motor products. Their motors, either alternate or direct current, are readily adaptable to overhead cranes, and quite a large number have been supplied for this class of work. The direct current motors are of compact design, but ample allowance has been made to avoid undue cramping of any part, more especially of terminals and connections. The motor frame can be so arranged that the complete machine can be bolted to the floor, wall, or ceiling, or to any portion of the apparatus to be driven. A special feature is made of the brush-holders, which are carried in a special casting, covered with vulcanised rubber at one end, and secured by suitable clamps so that they can be easily withdrawn from the machine. All motors are designed to stand heavy overloads, and will carry 50 per cent. overload for a quarter of an hour, and 20 per cent. for two hours, without undue heating or sparking. This is important considering the intermittent character of the load for the majority of electrical transporting devices, and should receive every consideration when specifying and ordering motors for this class of work.



P.D.M. CRANE MOTOR AND MAGNETIC BRAKE.

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LIFTING MAGNET RAISING A LARGE ALTERNATOR FRAME (ELECTRICAL CO.).

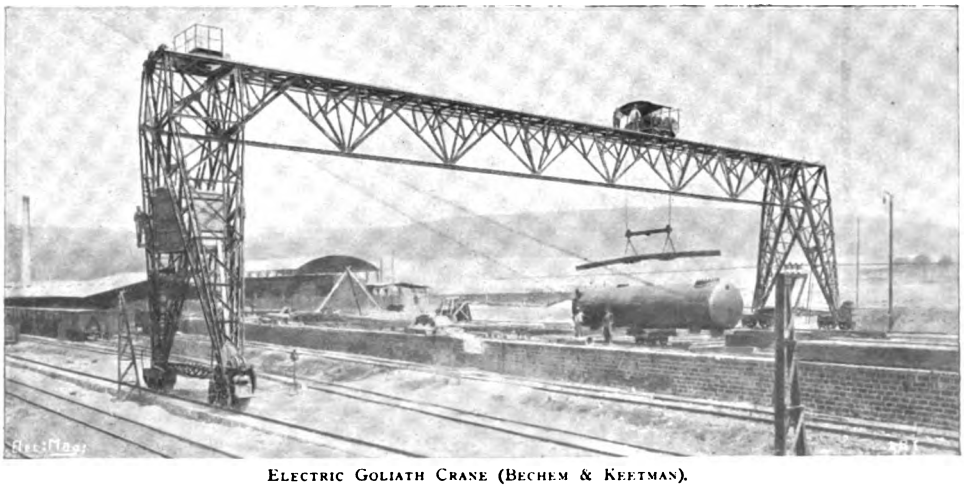
with illustrations. We give a view of a special form of lifting magnet attached to an electric crane and in the act of raising the stator yoke of a large alternator.

Goliath Cranes.

A useful form of crane for open yards is that known by the name of the Goliath. Messrs Bechem and Keetman, of Duisburg, have done extensive work with this type of crane. A feature of the construction is the stiffening of the frame with a view to obtaining perfectly parallel working. The example depicted is worked by three-phase motors and operates at very high speeds: the lifting speed is 85 feet per minute, the crab travels 390 feet per minute and the travelling speed of the crane 656 feet per minute. The load is carried by a special two-rope tackle fixed to the hoisting drum, which is grooved right and left. Electro-magnetic brakes, operated from a knee lever in the control carriage, are fitted to each of the wheels.

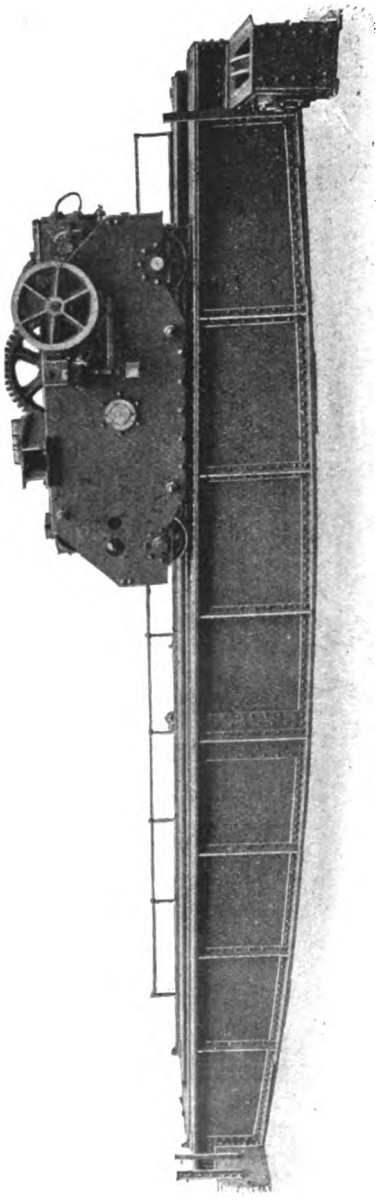
Crane Specialities.

The Electrical Company have made a speciality of electric cranes for many years and have supplied the electrical equipment for a great number of very important installations. These installations include cranes of varying capacities for docks, warehouses, wharves, quarries, and, in fact, almost every sphere in which transporting devices are needed. We could quite easily have filled the present Supplement three times over



ELECTRIC GOLIATH CRANE (BECHEM & KEETMAN).

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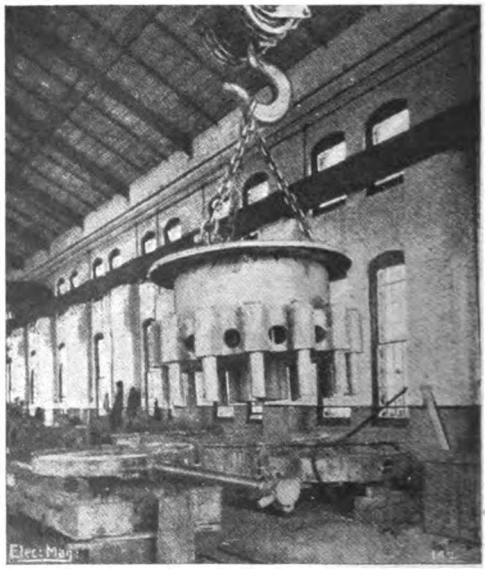
LARGE ELECTRIC TRAVELLING CRANE. HENRY BERRY & CO., LTD.

Lifting Magnets.

The importance of the electro magnet for lifting loose pieces of iron or steel has been better recognised abroad than in this country, consequently it is not at all surprising to find this useful lifting device widely applied in America and on the Continent. A firm which has specialised in this direction is the Electric Controller & Supply Co., Cleveland, Ohio. They supply pig magnets for handling pig iron, steel or iron scrap, baled or loose tin, bolts, nuts and rivets, plates, billets and blooms, rails, pipes, and sheets, the lift in each case varying from 500lbs. to 1400lbs. Some 25 to 50 per cent. is saved by using these magnets both in time, labour, and power expended. It is important to note that while chains quite frequently slip, magnets never do so. We have still to abandon our prejudices as to the safety of this class of lifting device.

Electric Travellers.

Messrs. Henry Berry & Co., Ltd., of Croydon Works, Leeds, who are far famed for their hydraulic machinery, have a special department for electric cranes and overhead travellers; an example of one of these is shown herewith. Single motors are fitted to those of small capacity, up to five tons for example, but for the larger sizes for loads up to 60 tons and over, three or four motors are provided.



PIG-LIFTING MAGNET.

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